JOURNAL OF THE SOCIETY OF

MOTION PICTURE

AND **TELEVISION**

ENGINEERS

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Observer Reaction to Non-Simultaneous Presentation of Pictures and Associated Sound

By Harold N. Christopher

The results of experiments to determine observer reaction to non-simultaneous presentation of pictures and associated sound are reported. Curves are presented for two groups of observers: (1) a conditioned or technical group, and (2) a group more nearly representative of motion picture or television audiences. The data given may be used to predict observer reaction to the lack of simultaneity between picture action and the resulting sound over a range of 0 to 300 milliseconds.

Due to the difference in velocity of light and sound in air, we, as observers, perceive action and then hear the sounds resulting from the action. This has resulted in a natural conditioning which causes the observer unconsciously to restore the action and sound to proper perspective. If, however, the delay in the sound path exceeds certain limits the observer not only becomes conscious of the delay but is likely to voice vigorous objections. Organizations dealing with the recording, reproduction or transmission of pictures and associated sound have recognized this and have found it necessary to maintain a reasonable degree of simultaneity between picture actions and accompanying sounds. It is the intent of this paper to give the results of tests to determine when the lack of simultaneity between the picture and the sound of a televised subject or sound motion picture becomes noticeable and objectionable, thus permitting a quantitative evaluation of the phenomenon.

The method employed was to record observer reaction to a series of presentations of actions and sounds in which the difference between the time of arrival of the visual and aural stimuli was carefully controlled. In order to facilitate the taking of data an arbitrarily determined comment scale was employed and is indicated below.

No.	Comment
1.	Not perceptible
2.	Just perceptible
3.	Definitely perceptible
4.	Definitely perceptible but not objectionable
5.	Somewhat objectionable
6.	Definitely objectionable
7.	Unusable

Presented on October 20, 1950, at the Society's Convention at Lake Placid, N.Y., by Harold N. Christopher, Bell Telephone Laboratories, Murray Hill, N.J.

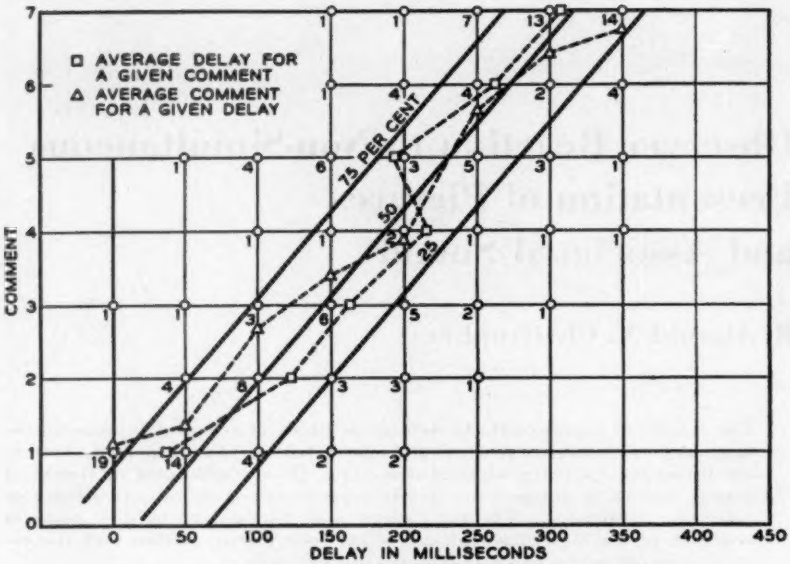

Fig. 1. Mechanical-percussion tests, sound delayed; 20 observers (nontechnical).

Distributions showing the percentage of all observations for an indicated comment number or less, for a given sound delay, (or advance) for talking and striking type actions and the resulting sounds are presented.

Summary of Results and Conclusions

The results of these tests indicate that the ability of an observer to detect the lack of simultaneity between action and the resulting sound is a function of the type of action and whether the sound is delayed or advanced with respect to the action. When the sound follows the action (normal order), delays in excess of about 100 milliseconds are likely to cause adverse comment. When the normal order is reversed and the sound precedes the action, 35 milliseconds advance is about the maximum unlikely to be objectionable. The above conclusions are based on observer reaction to the more easily correlated striking motions and percussion-type sounds. For scenes of people in conversation and moving about, the correlation between picture action and sound becomes more difficult for the observer and the above limits can probably be doubled.

Description of Test and Data

The first test devised and used in this study employed a complete television chain and a tape recorder with a movable reproducing pole-piece. This array of equipment permitted the televising of a subject talking or striking an object and the delaying of the reproduction of the sound by known amounts of time by means of the tape recorder. As the test proceeded, numerous questions arose concerning the adequacy of the quality of the pictures and the sound channel. Both were improved considerably but appeared to have little effect on the results. Direct-viewing tests were then resorted to, eliminating first the television equipment and finally the tape-recording equipment. This was

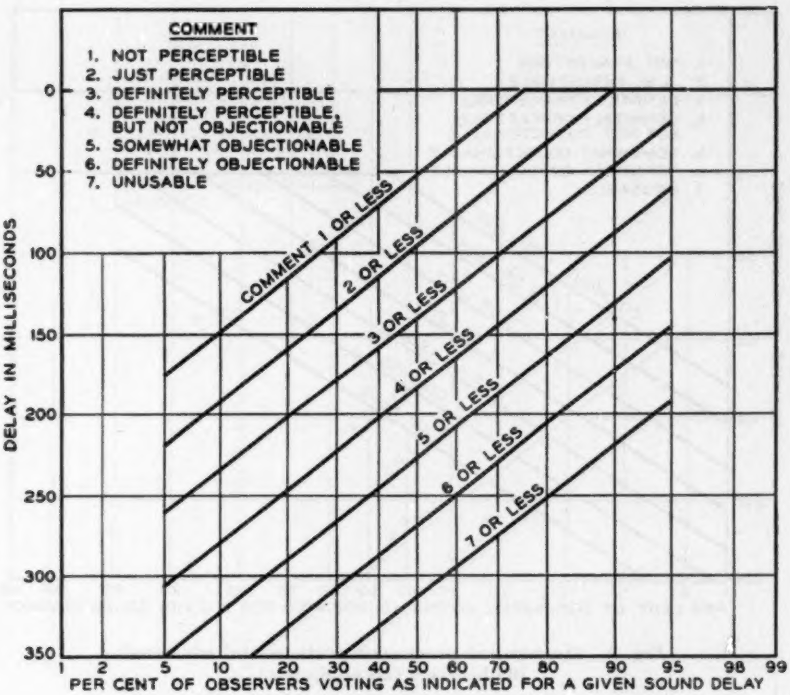

Fig. 2. Mechanical-percussion tests, sound delayed; 20 observers (nontechnical).

made possible by a simple mechanical device consisting of two cam-actuated felt hammers, one of which struck a dead microphone a sharp blow and returned rapidly to its striking position in full view of the observer. The second hammer, not visible to the observer, struck a live microphone causing a sharp popping sound in the sound reproducing system.* By indexing the second cam with respect to the first it was possible to produce at will a sound that was delayed or advanced with respect to the visible striking of the hammer. Only tests herein termed "mechanical percussion" employed this device and were made by determining observer reaction to a presentation of intermixed delays and advances. Tests other than mechanical percussion permitted an irregular presentation of delays only. The instruction to the observers for all tests was to focus their attention on the picture action and vote their reaction to the lack of simultaneous presentation in terms of the numbered comments, a list of which was before them during the test. No time limit was imposed. A given condition was presented repeatedly, and changed only after the observer had commented.

Two groups of observers were em-

* The loudspeaker was located about 3 ft in front of the observer, slightly to his right but almost in line with the action, at about eye level. The striking hammer was approximately 8 ft in front of the observer.

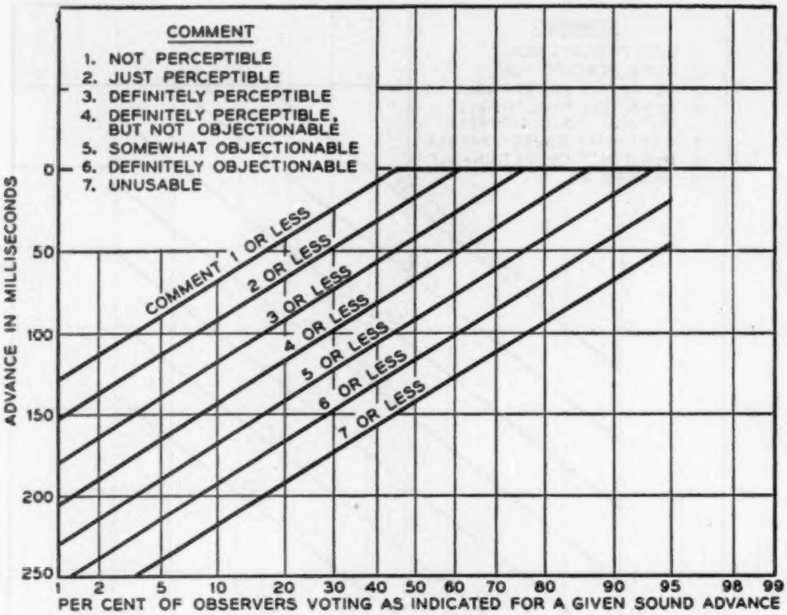

Fig. 3. Mechanical-percussion tests, sound advanced; 10 observers (all engineers).

ployed, the first consisted of a conditioned group, indicated as, "10 observers, all engineers." In each test, however, the observers were not always the same 10 people. They were, in general, engineers familiar with problems involving pictures and sound.

The second group totaling 20 people, consisted of 4 engineers and 16 other observers, most of whom were draftsmen and included 5 women. This group although more nearly representative of a picture audience was comprised of people probably above average in technical background and understanding.

The observer comments for the mechanical percussion tests are listed in Table I. An examination of these data indicates that both observer groups comment more severely when the sound occurs before the action and it also appears that the 10-observer group is somewhat more critical (they comment more severely sooner) than the 20-observer group. The information or intelligence that appears desirable to extract from these data if possible is: (1) how severely would these groups react to a particular delay or advance in milliseconds; and (2) what delay would cause a given percentage of the observers to make the comment 4 or less. This would require two forms of processing, one in terms of average comment for a given delay and the second in terms of average delay for a given comment.

Figure 1 plots the "20-observer, mechanical-percussion test, sound delayed" data in the form of the matrix, in which the numbers at each data point correspond to the total vote for a given comment at that delay as indicated in Table I. The 50% points of the two

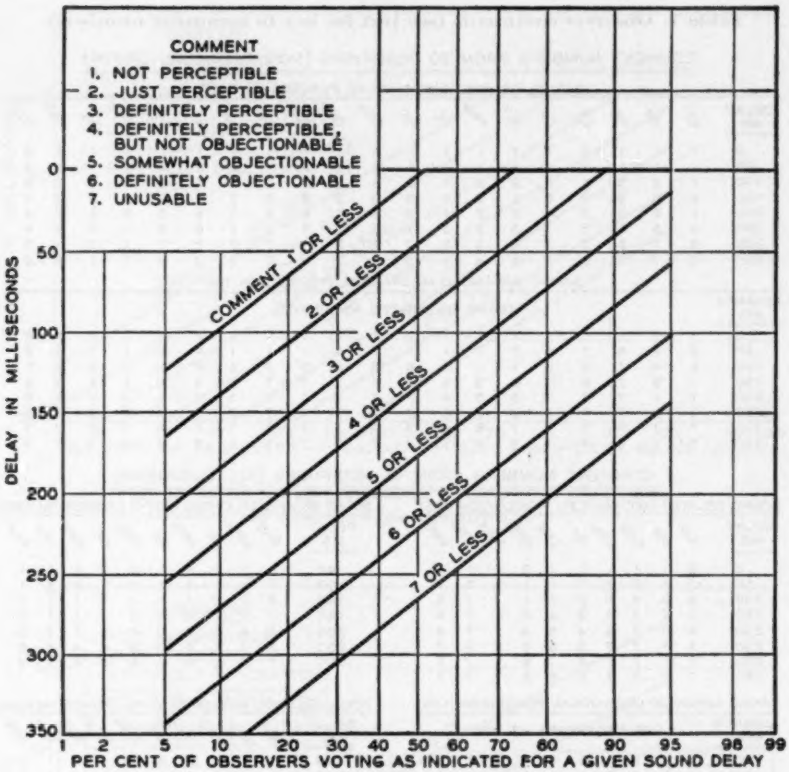

Fig. 4. Mechanical-percussion tests, sound delayed; 10 observers (all engineers).

methods of processing mentioned in the above paragraphs are indicated by the light dashed lines on the matrix. Through these lines the heavy straight line captioned 50% curve has been drawn.

In a similar manner, although not shown in detail, the lines captioned 25% and 75% may be located.

That the calculated 50% values deviate in an irregular way from the straight-line 50% curve is evident and typical of all data presented here. It is felt, however, that the straight-line 50% curve as indicated is a practical representation of the observer's evaluation of the delay phenomena in terms of the comment scale, for either method of processing. It is also plain that straight line curves labeled 95% or 5% if shown on Figure 1 would fall in meager data areas and, therefore, would perhaps be less representative than the 50%, 25% or 75% curves.

Figure 2, a cross plot of the straight-line data shown on Fig. 1 results in a family of curves indicating how the 20-observer group reacted to delaying the sound with respect to the action for the mechanical-percussion test.

Let us assume, for example, that we wish to predict how this group of people

Table I. Observer comments (see text for key to comment numbers).

COMMENT NUMBERS FROM 20 OBSERVERS (NON-TECHNICAL GROUP)

SOUND DELAYED MECHANICAL PERCUSSION TEST

DELAY MS	EK	JM	RB	CE	LP	RLF	FRM	JC	RE	CHH	DWG	JLW	HTS	HAS	ADF	MFW	EHH	ML	HGR	STP
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3
50	1	1	1	1	1	1	1	1	5	2	1	2	1	2	2	1	1	1	1	3
100	1	2	5	1	2	2	2	1	5	3	2	2	3	5	5	1	4	2	2	3
150	2	5	5	3	5	1	3	1	5	3	3	5	5	7	6	3	2	4	2	3
200	1	3	5	3	6	2	2	1	6	3	5	4	3	7	6	5	6	3	2	4
250	3	6	5	5	7	3	2	5	7	7	5	7	7	7	6	6	7	5	4	6
300	6	7	6	7	7	4	3	5	7	7	7	7	7	7	7	7	7	7	5	5
350	6	7	7	7	7	4	6	5	7	7	7	7	7	7	7	7	7	7	6	6

SOUND ADVANCED MECHANICAL PERCUSSION TEST

(SAME OBSERVERS AS ABOVE)

ADVANCE MS																				
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
50	4	2	4	1	3	1	1	1	1	1	4	1	1	1	4	1	1	1	2	2
100	6	4	7	5	3	1	1	5	6	2	6	6	6	5	6	1	7	2	2	5
150	7	3	7	6	7	4	3	5	7	7	7	7	7	7	7	5	7	7	3	5
200	7	7	7	7	7	5	6	6	7	7	7	7	7	7	7	7	7	7	6	6
250	7	7	7	7	7	7	6	6	7	7	7	7	7	7	7	7	7	7	7	7
300	7	7	7	7	7	7	6	6	7	7	7	7	7	7	7	7	7	7	7	7
350	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

COMMENT NUMBERS FROM 10 OBSERVERS (ALL ENGINEERS)

SOUND DELAYED MECHANICAL PERCUSSION TEST

DELAY MS	ADF	MB	COM	CRM	RA	CFM	GRS	MKA	WTW	VWD
0	2	1	1	1	1	1	2	2	1	1
50	3	5	3	2	1	1	1	1	3	1
100	2	5	4	5	2	2	1	5	7	5
150	3	7	7	6	2	4	4	4	7	4
200	6	7	7	5	4	5	4	7	7	6
250	7	7	7	7	3	6	6	7	7	7
300	7	7	7	7	6	7	6	7	7	7
350	7	7	7	7	5	6	6	7	7	7

SOUND ADVANCED MECHANICAL PERCUSSION TEST

(SAME OBSERVERS AS ABOVE)

ADVANCE MS										
0	1	1	1	1	1	1	1	1	1	1
50	1	5	1	6	1	5	4	1	2	2
100	6	6	7	7	5	7	6	7	7	7
150	7	7	7	7	6	7	6	7	7	6
200	7	7	7	7	6	7	6	7	7	7
250	7	7	7	7	7	7	6	7	7	7
300	7	7	7	7	7	7	6	7	7	7
350	7	7	7	7	7	7	6	7	7	7

SOUND DELAYED TELEVISED TEST—H.G.FISHER TALKING

DELAY MS	RHB	MFM	JH	MKA	GN	DMC	DC	RWE	ADF	HGF
40	1	1	2	1	1	2	2	1	1	1
100	2	1	1	1	1	2	1	1	1	1
125	2	1	2	1	1	3	1	1	1	1
150	3	1	1	3	2	2	1	1	1	2
200	5	1	2	3	2	5	3	1	2	3
250	5	3	5	4	3	5	4	4	2	6
300	7	6	5	6	5	6	6	4	5	6

SOUND DELAYED WINDOW TEST—H.G.FISHER TALKING

DELAY MS	RHB	MEM	VWD	JRH	BG	MWB	WTW	MVS	ADF	RWE
40	1	1	1	2	2	1	1	4	1	1
100	1	1	2	2	1	1	1	4	1	1
125	1	1	4	3	2	1	1	4	1	1
150	1	2	3	3	3	1	3	5	1	1
200	2	5	3	4	1	3	2	4	1	1
250	5	6	5	6	5	7	5	6	2	2
300	6	7	4	7	5	7	6	5	2	2

would react to a delay of 100 milliseconds in the sound track of a motion picture involving motions that result in percussion-type sounds. From Fig. 2 we note that 87.5% would make the comment 4 or less (12.5% would vote 4 or more), that 96% would vote comment 5 or less, and 4% would comment more severely than comment 5. In other words, with this family of curves, if we know the delay we can determine or predict how many observers would object to the non-simultaneous presentation.

Figures 3, 4 and 5 are to be interpreted as described above for Fig. 2 for the observer group and test conditions indicated in the figure captions.

Data from two other tests are given in Table I. One test employed a complete television chain and tape recorder to produce the various delays, and in the other the speaker was observed through a window in a sound-proofed panel, the sound being delayed by means of the tape recorder.

These data, when processed as previously described, resulted in distribu-

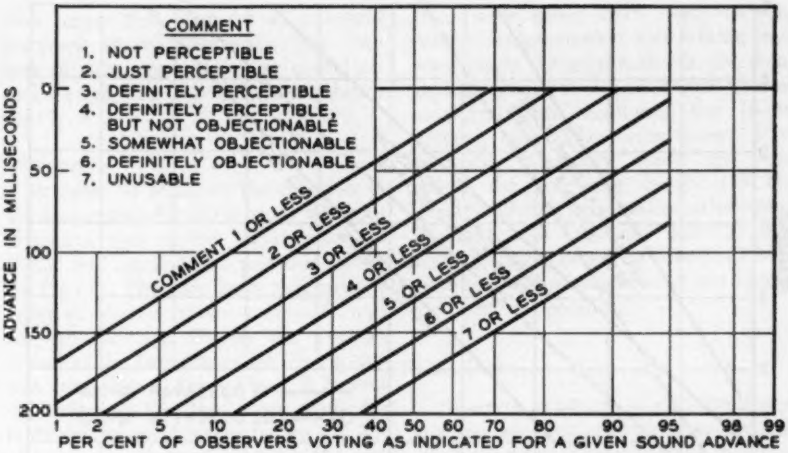

Fig. 5. Mechanical-percussion tests, sound advanced; 20 observers (nontechnical).

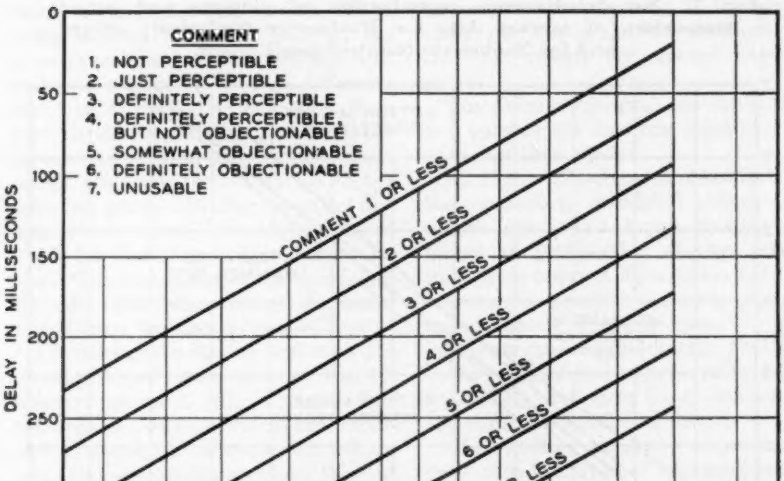

Fig. 6. Average of talking tests; 10 observers (all engineers). Effect of delay in terms of comment scale.

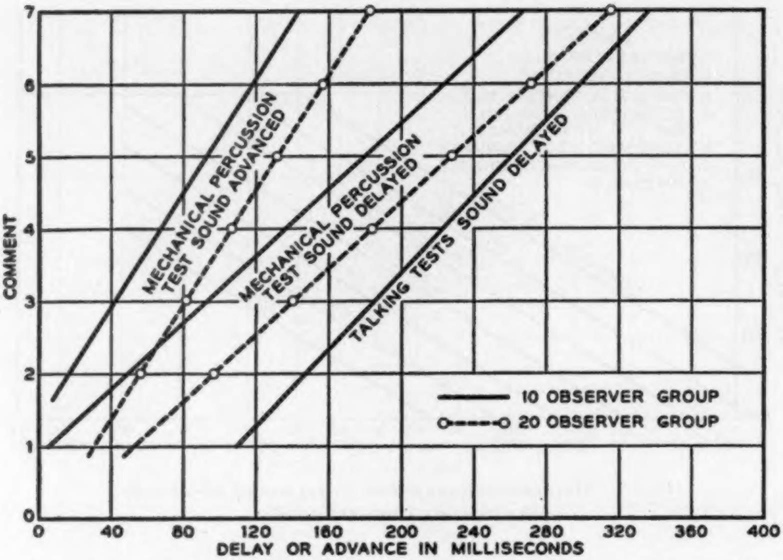

Fig. 7. Non-simultaneous reproduction of pictures and sound; comparison of average data for 10-observer (technical) group and for 20-observer (nontechnical) group.

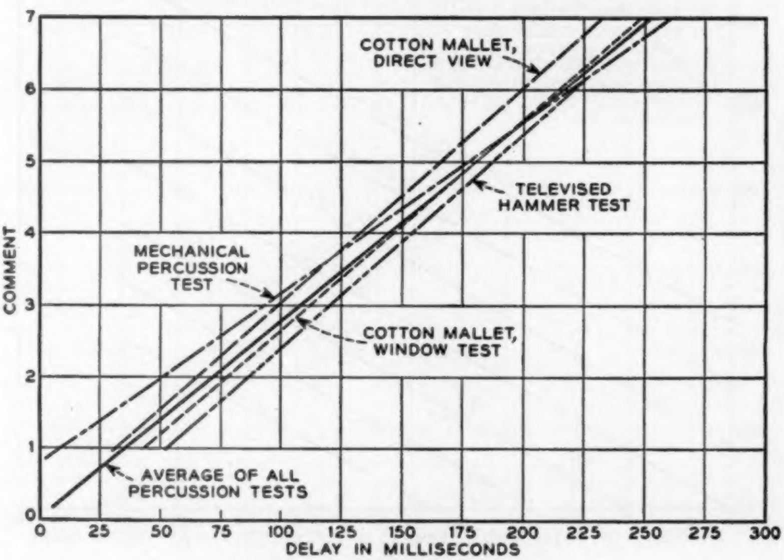

Fig. 8. Comparison of percussion data; 10 observers (all engineers).

tion curves that were for all practical purposes almost identical. The two sets of data were therefore combined and the resulting distributions are shown on Fig. 6.

Discussion

In order to compare the reaction of the two groups for the various test conditions a plot of the 50% values as found on Figs. 2, 3, 4, 5 and 6 is shown on Fig. 7. Here we have milliseconds delay or advance versus comments, and we can compare directly the average curves of the two groups for the various test conditions. From Fig. 7 it is seen that although the 10-observer group detects delays or advances before the 20-observer group, the curves for the two groups parallel each other. A constant difference of approximately one comment is indicated for the delay condition and 1.5 comments for the advance condition. This points out a rather nominal difference between the average technical and the average nontechnical observer. If this difference could be attributed to education, it is possible that repeat data on the 20-observer nontechnical group might more nearly approach the evaluation of the technical group. Another factor not discussed but evident in the tabulations on Table I is that of audio-visual coordination. The importance of this factor and the education factor cannot be determined from the data presented here.

Comparing the talking test with the mechanical-percussion test for the 10-observer group it will be noted that the average observer finds it more difficult to detect the delay for the talking test and therefore appears more tolerant of delays that involve correlation of sounds with lip motions. The slope of the talking test curve indicates a somewhat different evaluation of the delay phenomenon; the difference however appears too small to be significant.

As mentioned briefly in the description, tests other than direct-viewing mechanical-percussion and talking tests were made. Figure 8 shows, for comparison purposes, four different percussion-type tests employing the 10-observer group. These curves show a remarkable similarity when one considers the following facts: (1) the greatly different presentation as indicated by the curve captions; and (2) that although 10 observers are indicated for each test, the observers were not always the same 10 people.

Conclusions

Observer reaction to non-simultaneous reproduction of pictures and sounds has been rated subjectively by means of an arbitrarily determined scale of comments.

Although a nominal difference is indicated in the evaluation of the phenomenon for technical and nontechnical observers, the subjective reactions of the two groups are almost exactly parallel.

The average observer detects earlier and voices more vigorous objections to advances than delays.

For delays, the objectionable effects of the more easily correlated actions and sounds (percussion type), though detected at considerably shorter delays than those between lip motions and the corresponding sounds, appear to grow at approximately the same rate.

Differences in presentation that involved picture and sound quality have little or no bearing on the evaluation of the more easily detected delays.

The repeated similarity of processed data when displayed or compared in the form of average curves (Fig. 8) suggests that the findings herein presented, though determined from observations of a relatively small number of people, would be changed or modified rather little had a greater number of observers been employed.

The Television Cameraman

By Rudy Bretz

The requirements of the television medium and the unique design of television cameras have developed, in the best of television cameramen, operators of unusual skill. A broad picture of the abilities and backgrounds of present-day television cameramen is presented, and a general comparison is made between the television cameraman and the motion picture camera operator. The creative role of the cameraman and his relationship to the television director are explained in an outline of the stages of camera rehearsal.

Handling the camera is a highly creative job, and there is a tremendous difference between a good and a mediocre cameraman. The ability of a television cameraman depends on certain basic abilities, but is also due in large measure to his attitude toward his job. This in turn seems to hinge primarily on the position of the cameraman within the station organization.

About half the stations have been classifying cameramen as engineers. Not all of these require the cameraman to have a very thorough technical knowledge. At about half of these stations, the cameramen-engineers are assigned to camera operation and nothing more, and they are expected to be experts only in the art of camera handling. The balance of these stations employ no cameramen as such, but apply a policy of rotation of the engineering personnel. An engineer may be assigned to the camera one week, to maintenance of equipment the next and as technical director the third. This is considered good management because it keeps the staff flexible; in case of illnesses or vacations it is possible to replace people easily, and more can be accomplished with a smaller staff. However, all engineers must then be well-trained technical men with a thorough knowledge of circuits and electronics. In most cases, such men do not particularly care for camera handling. Operating the camera calls for none of the special knowledge and skill which the technical man has acquired through his years of engineering study. At the same time, his background has been weak in the understanding of composition, picture showmanship and the visual arts. In many stations the engineers speak of the camera assignment as the "salt mine," endure it for as long as they must and make very little effort to contribute anything creative to the production at

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A contribution submitted January 10, 1950, by Rudy Bretz, Television Consultant and Producer. This is part of a forthcoming book and is published by permission of McGraw-Hill Book Co., Inc. Critical discussion of this material is particularly invited, either in the form of Letters to the Editor or by communication directly to the author at Croton-on-Hudson, N.Y.

hand. In such a setup the producer has a much more difficult job doing a good show.

The other half of television cameramen are classified in the production departments. They are responsible to the program director rather than to the chief engineer. Some stations even rotate personnel between cameras and other production jobs. A man may direct one show, take the camera for the following production, and then put in a stint as audio-console operator or projectionist before the next show that he produces comes around. This is, of course, only possible in small towns where there are no iron-clad union jurisdictions. Such rotation means efficient station operation, and at the same time assures that the camera work will be as creative as possible. It also helps to eliminate social strata within the production organization.

The job of cameraman is only one of a group known as operating jobs. Such duties as dolly-pushing, mike-boom operating, audio-console operating, the jobs of technical director, projectionist, record spinner, etc., are not strictly *technical* jobs. In none of these positions does the operator have to understand more than the mechanics of operation of his equipment. He is not called upon to repair or redesign, but only to operate, and skill of operation rather than engineering is required. A few television stations do classify all these jobs under the program department. An understanding of showmanship is of greater value than a technical background in an operating job, and when production people are placed in these positions creative contribution is more likely to result.

This is not to say, of course, that no engineers have any concept of showmanship. There are many engineers in television who, through particular backgrounds or extensive control-room experience in television or radio, have developed an understanding of the elements of showmanship that would actually qualify them as directors. The best of the "technical directors" fit this description.

Aptitudes of the Successful Cameraman

Whatever the cameraman's classification with the organization may be, he will become really good only if he has two essential aptitudes. The first is a sense of composition and the second is a well-developed manual coordination.

The sense of composition comes only from long familiarity with a picture medium. A man who has been a still or motion picture photographer, or perhaps has worked on a picture magazine, has been thinking in terms of pictures and developing this sense. "Reading up" on composition doesn't help. It is not possible for the television cameraman, or director either, for that matter, to apply rules for composition while he is making pictures. He must be able to look at a picture, see what is wrong with its composition, and, by a conditioned reaction, as the psychologist would put it, unerringly make a quick adjustment to improve it.

Manual dexterity and coordination come only to those who are endowed with the necessary aptitude. Just as it is impossible to teach some people to fly an airplane, so it is impossible to teach some people the smoothness and dexterity necessary to operate the television camera. A man who lacks the feeling for composition, but has coordination, may learn the former in time; if he lacks the aptitude for physical coordination, he will never be a good television cameraman, no matter how finely developed his pictorial sense may be.

Television and Motion Picture Cameramen

Perhaps the unique nature of the television cameraman can best be explained if he is compared with the near-

est thing which existed before the advent of the television medium—the motion picture cameraman. The comparison is not an easy one to make and possibly an accurate parallel can be drawn to only one phase of the film cameraman's work. For one thing, the television cameraman has no responsibility for lighting or exposure, or for picture quality except in regard to composition and smoothness of camera movement. He compares most closely to the operating cameraman in Hollywood who, as an assistant to the director of photography, is concerned only with handling the camera.

At first comparison the television cameraman is seen to have a lot more to do than his motion picture counterpart. The job of handling a motion picture camera is only a job of framing the picture. The camera operator controls the camera with the panning handle, pans the camera left and right, or tilts it up and down to keep a good composition. If the camera dollies in or out, or the subject moves toward or away from the camera, the focus must be adjusted on the lens barrel, but the cameraman has an assistant to help him in this operation. The assistant rides on the front of the camera dolly watching chalk marks on the floor. As the dolly wheel passes the 10-ft mark, he sets the lens to 10 ft; as it passes 8 ft, he has moved the focusing scale to 8, and so forth. If he cannot see the chalk marks on the floor, a second assistant walks alongside and whispers the distances in his ear. It is clear that this method of following focus can only be used when adequate rehearsal of each shot is possible. The television camera had to be designed so the cameraman himself, without preplanning, can adjust focus to whatever motion is taking place within the scene.

The television cameraman will often control his own camera movement as well. Many of the camera dollies used in television stations today may be operated by one man and, in general, a good cameraman can usually work better alone than with an assistant.

In the television camera, then, more aspects of the camera's operation are under one man's control. This gives him more work to do in one sense, but relieves him of a great burden at the same time—the burden of coordinating the actions of two or more operators. When one man is operating, he is subject to a certain possibility of human error. When two men are operating the same camera, however, the factor of human error is not merely doubled, it is multiplied by four. Each man's errors reflect upon the other. When as many as three operators must cooperate in the operating of a single camera (the counter-balanced-crane type of camera dolly requires three men), the factor of error may be increased by nine. Equipment such as this can be used to best advantage only when plenty of rehearsal time is available.

The exception to this is the cameraman-dollyman team which has worked together so long that each man knows the other's reflexes and the two can operate with a single accord even when covering spontaneous action.

The television cameraman develops more rapidly in his craft and reaches a high level of skill in much less time than it takes his motion picture counterpart. This is due to two factors: the actual amount of camera handling he does, and the fact that he can see his results as he works.

In the usual motion picture studio, the largest part of shooting time is taken up in adjusting lights, rehearsing actors and in a thousand details of production. If an average day's shooting amounts to, say, five minutes of finished film, it can be assumed that the camera was in actual operation on takes and retakes, or on rehearsals before the takes, perhaps a maximum of twenty or thirty minutes. It was only during this time that the cameraman was practicing his

skill. Like a musician who spends most of his day adjusting his piano, and only thirty minutes playing the instrument, he has acquired only a half hour of practice toward the mastery of his instrument.

The television cameraman, on the other hand, works his eight-hour day in almost constant camera manipulation. The director invariably comes into the studio with more show to produce than he has rehearsal time for, and pushes the camera crew as hard and as fast as he possibly can. Of course, the cameraman is not working at top efficiency all this while—if there are two or three cameras involved in the studio rehearsals, only one bears the entire burden of the production at any one time, while the others reposition for their next shots. There are moments, too, when the director is concerned with problems of acting, staging or audio, during which the cameraman can relax. It is safe to say, however, that a good three hours of his eight-hour day are devoted to actual camera handling. In comparison with the motion picture cameraman, then, he gets six times the experience in the same period of time.

Not only does the television cameraman get more training, but he gets better training because he can see the results of his efforts as he works. The motion picture man is at a great disadvantage in this respect. He must resort to complicated routines of measurement, using light meters and measuring tapes, simply because he cannot see whether the picture is well exposed or whether the subject is in focus. Likewise, the film cameraman who executes a dubious pan shot may think it is entirely acceptable until he sees it on the screen the next day. During that twenty-four hours, however, he has allowed a false impression to crystallize in his mind. He must find out his mistake and unlearn it before he can return and improve his technique. The television cameraman is under no such disadvantage. A poor shot is immediately evident to him; he corrects the error at once, and the lesson has been learned.

With these factors in mind, then, it is easy to understand why the best of television camera work is on such a high level. A good cameraman, after a year or two on the television camera, has learned his equipment so thoroughly that it is practically an extension of his own body. He can seemingly make the camera do anything and go anywhere, and do it smoothly and perfectly the first time. He has developed techniques of handling the cameras and the camera dollies which the manufacturers of the equipment never imagined. It is not correct to say that the best of television camera work is superior or even equal to the best of motion picture shooting—the film medium will probably always show superiority in production techniques. The flexibility of the television camera, however, and the ability of the cameraman to produce complicated shots smoothly and without rehearsal, is something entirely new in camera handling, and in this the good television cameraman is far superior to his motion picture counterpart.

Television camera techniques are beginning to influence motion picture production and will probably have a wide application in the studios where speed and efficiency in production are important. Methods of continuous shooting have been developed where several cameras operate at one time, repositioning between shots much in the manner of television cameras. One method utilizes a small industrial television camera which is coupled to each film camera enabling the director to watch the shots and direct the cameraman from a control position just as in television production. In motion picture production of this type, the film cameraman is operating in the same manner as a television cameraman, al-

though his equipment is somewhat different.

The recent development of the television recording technique, which makes it possible to film a television show off the face of a kinescope tube and distribute it among television stations, just as any film is distributed, may well become a standard method of film production, at least of films for television use. Recent improvements in television recording technique indicate that the time is not distant when television cameras and studio equipment will be installed by film producers, and the motion picture camera operator will have to learn the television cameraman's technique.

Creativeness in Television Camera Work

The television director is responsible for planning the creative use of the camera, although he may lean heavily on the advice of his cameramen or his technical director.

Some stations, notably those operated by NBC, use the "technical director" system, in which the technical director operates as a kind of head cameraman. He will be familiar with the show rehearsals, and will have had a share in the planning of shots and camera angles. During studio rehearsal he is in charge of the operation and placement of cameras, and is usually the only one who gives directions to the cameramen.

Proponents of this system see in it an analogy to the method of Hollywood production, in which each film has two directors, one of whom is the "Director of Photography" and is in charge of all technical aspects of the production, while the other who carries the title of "Director" concerns himself largely with the broader problems of staging and acting. One director, who has directed programs on many stations, has said that working under the NBC system is like having a twin directing the program with you. During rehearsal much time can be saved. When in the course of rehearsal a stopping point is reached, the director can go out on the studio floor, make corrections in the action and come back to the control room to find all the camera changes made and everything ready to go again. Of course, this is predicated on the ability of the technical director. He must have almost as good a background as the director himself. He must be primarily a showman, not an engineer. Where this method is in use, however, the job of technical director is always an engineering job. The technical director must be in charge of the camera and control-room crew, and for this reason must be a superior engineer. Men who can fulfill all these requirements are rare or cannot be found for the salaries that are offered.

The technical-director system breaks down when an inexperienced man is on the job, or when an "ad-lib" show is attempted. The writer has observed a green director, a green technical director and green cameraman attempt to use this method; and the results were miserable. The director would give a camera order, and the technical director would garble it a little in relaying it to the cameraman, since he had no clear idea of what was meant. Then the cameraman would do the wrong thing. "No! I didn't mean that!" the director would tell the technical director. "I meant so-and-so!" This was again relayed to the cameraman. This time the cameraman would make an error. When it was all finally straightened out and everyone knew what it was the director wanted, it would turn out to be something that couldn't be done anyway because of some technical factor which no one had anticipated.

During an ad-lib show, camera and cutting instructions must be given very rapidly and acted upon immediately, or action is lost. Sudden instructions to the cameramen cannot originate in the

director in these cases, since by the time they are relayed through the technical director, the moment has passed. To be sure, the technical director himself may make the sudden decisions; but he is acting then in the capacity of director, which very few technical directors are able to do, or would be allowed to do. A good technical director could assist the director by keeping one step ahead of him. He could so engineer the cameras that the director would have a variety of shots to choose from in calling takes, and one camera at least would always have a good shot, well framed, from the proper angle to show the action, and ready at the right time. However, there is some question as to whether this could not be done just as well or more easily by the director himself. It is a general opinion that for ad-lib shows the technical-director system does not work. Since most television stations must do the ad-lib type of production (and practically all remote pick-ups fall into this category) most stations (90%) have decided against this method.

A good compromise is achieved in some stations, and some network studios where both the director and the technical director may talk to the cameramen at any time. This makes quick decisions possible and at the same time provides a two-director team for the rehearsal and production of the show. After operating under this joint system many people have observed that the usual method, whereby the technical director simply operates the switching system under the director's command, wastes the capabilities of this individual who could be assisting the director at the same time.

From script to screen the production may go through many stages, or few, depending on the complexity of the production, and the time allowed for rehearsal. Commercial dramatic programs usually enjoy a rehearsal ratio of 10 hr of rehearsal with cameras to 1 hr of air time. Sometimes important shows have rehearsed with studio facilities at a ratio of 15 or 20 to 1. Under these optimum conditions, the following stages may be observed.

Stage 1—The Paper Stage. Detailed preplanning is absolutely vital to television production. In the paper stage, the director works with floor plans and shot plotters; he makes little sketches on the script of what the shots should look like; he visualizes the positions of the cameras in the studio; draws them on the floor plans for every shot, and insures that everything he visualizes is practical and will work.

Stage 2—Outside Rehearsal. Rehearsals of complicated shows always begin outside the studio in a rehearsal hall or some suitable space. The plan of the studio sets is marked off on the floor; chairs or other furniture are used to simulate sets and props, and the performers get a good idea of the space in which they are to work. Here the director will move about, taking the place of one camera and then the other, as he views each shot from the position of the camera that will take it. Some directors use a portable view-finder with lenses, which will give them the field of view of the television camera lenses. This instrument is available on the market at a rather high figure. Other directors use homemade view-finders, frame viewers or a simple shoe box finder with a cut-out mask. Most directors, however, frame a picture with their own hands. Some use their arms, some their fingers, but the result is the same—an easier visualization of a picture within a 3×4 frame. (See illustration on following page.)

If it is possible economically, the ideal thing is to show the cameramen an entire rehearsal of a show outside the studio before the first use of cameras on the studio floor. Studio rehearsal with facilities is, to a large extent, a period for briefing the cameramen, the floor manager, the stage crew and the control-room personnel on the many aspects

Several methods which directors use to help them plan camera shots.

of the show which the director has previously worked out on paper and with the cast. If the cameramen have seen the show before rehearsal, much of this time can be saved. Further, the cameramen are authorities on the problems of space and traffic on the studio floor and can spot difficulties of which the director may be unaware. And finally, the creative mind of the cameraman, and his own powers of visualization, are a great help to the director in this planning stage.

Stage 3 — Dry-Run. Many directors prefer to use their first hour or so of studio rehearsal for a dry-run, that is, to walk through the show from beginning to end without using the electronic facilities at all, working with the cameramen and crew on the studio floor. Positions of cameras and angles of view are more easily visualized here than in either the paper stage or in the outside rehearsal stage of development.

Stage 4 — Rough Run-Through. A fourth stage is sometimes added here—a straight run-through of the entire show, paying no attention to all the mistakes, rough places and problems that turn up. This can be very valuable for the crew, especially for the stagehands who must make scene changes or work props during the show. Only a complete run-through with cameras can give them a total picture of the show, and without it they will be somewhat confused until the last dress rehearsal puts all the pieces together for them.

Stage 5—Work-Through (Stop-Start). This stage is the stop and start or "work-through" which will take up the major portion of the rehearsal period. The director works through the show, stopping whenever necessary and working out all his problems as he comes to them. It is during this rehearsal that all the fine details of camera work will be set, and the cast and cameras will be coordinated.

Stage 6 — Run-Through. The sixth stage is the final run-through which is done preferably without stopping. Some directors will run through the show as many times as possible before air time, others may rest content with one good dress rehearsal and spend the remaining time working on difficult sequences. More often, there is time for neither, and sometimes a show is worked through so close to air time that there is not sufficient time for a complete run-through at the last. Most of the small stations, when they attempt dramatic shows or other complicated types of programs, cannot allocate sufficient rehearsal time for all these stages. In such cases, all the steps are eliminated except the paper stage, the outside rehearsal and the work-through.

Opinion is divided as to how much responsibility should be vested in the cameraman for finding the right shot at the proper time. In the case of the unrehearsed show where there is no set sequence of shots, the cameraman is usually relied upon to "hunt for shots" when he is off the air. The director may look at a shot the cameraman has found and say: "No, I don't want to use that," or "that's good, give it to me again when I tell you," or he may switch it immediately into the program.

At the opposite end of the scale is the method of operation in which the cameraman makes no move at all, except the very obvious, without instructions from the control room. It is a generally accepted principle that a cameraman should operate like this while his camera is on the air, but most stations give him greater freedom and more responsibility between shots.

In the case of the scripted and rehearsed show, the cameraman will always be supplied with cues from the control room to remind him of his next shot each time he is switched off the program line. In many studios, however, he is expected to take the major responsibility, and will keep a cue sheet on the camera listing each shot as it becomes established in rehearsal. He will often mark the studio floor so he can find the exact camera position that was established in rehearsal for each shot.

Some of the better cameramen are strongly opposed to this method, however; they feel that the important thing is the shot, not the camera position, and since the actors' positions may vary between rehearsal and air, the camera may sometimes be on the right mark and not have the proper shot at all. This same principle is relevant to the calling of lenses. Some directors like to specify the lens that will be used on each shot, and call for that lens during the show. These cameramen feel that much more flexibility should be possible, and that the cameraman need only be reminded of the shot he is to take and then allowed to find it, using his own discretion as to the necessary lens or camera position.

A Simplified Index for Color of Illuminants

By Frank F. Crandell, Karl Freund and Lars Moen

A new improved unit for the trichromatic measurement and description of illuminants is presented. Described are: methods of derivation; relation to Kelvin color temperature scale; application to color film, filters and light sources; and a three-color instrument for measurement of light sources using this new Spectra Index unit.

One year ago, at the Society's Convention, a paper was presented on "The Effects of Color Temperature on Motion Picture Production."[1] It was pointed out at that time that for practically as long as color photography has existed, photographers and cinematographers have been plagued by the problem of color balance between the sensitized material employed and the light source to which it was exposed in making a picture.

Some illuminants, such as flash, are quite constant in color. Incandescent light is variable but can be held within fair tolerances. Some sources are unsuitable for existing color films, though reasonably constant in hue.

Daylight, however, is quite another story. The amounts of red, green and blue in daylight change with the hour, the season, the altitude and latitude, with the state of the sky and the weather, with atmospheric contamination—in a word, with so many variables that no table and no computer could possibly cope with them. As for the human eye, it is a notoriously poor judge of illuminants because of its elastic power of adaptation.

In a confused situation such as this, no one will dispute the need of two specific things: an adequate instrument for the measurement of the spectral energy distribution, or color balance, of any given illuminant, and a convenient unit or index number in which the readings of that instrument can be expressed.

The solution of this problem which has existed until the present is well known to most color photographers. For lack of anything better, a unit was borrowed from the illuminating engineers—Kelvin color temperature. This is the temperature on the Kelvin or absolute temperature scale to which a black body would have to be heated to give off light of the color in question.

The unfortunate shortcoming of "color temperature" is that, while it may be quite accurate in dealing with incandescent light sources (which are virtually "black bodies"), it is wholly inadequate in dealing with daylight and most other artificial illuminants. The

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Presented on October 17, 1950, at the Society's Convention at Lake Placid, N.Y., (read by Norwood L. Simmons), by Frank F. Crandell, Karl Freund and the late Lars Moen, Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif.

reason is simple. The Kelvin scale is adequate for the ratio of any given *two* colors in the spectrum (say, for example, the middle of the red and the middle of the blue) but for any given third color there is only one possible value at a given ratio of the other two. For example, for any given blue–red ratio, green can have only one value, as expressed in Kelvin color temperature. Since any illuminant other than incandescent lamps is highly likely to have more green or less green than a black body, color temperature fails to describe it.

Since incandescent lamps commonly used for color photography can be rated on the Kelvin scale, the practice has grown up, rather haphazardly, of marking color film as Type A (3400 K), Type B (3200 K), and "Daylight" (Kelvin temperature not specified, though usually assumed to be 5900 or 6100 K).

This has worked reasonably well in practice, under perfectly normal conditions. However, many kinds of "daylight" prove to be something quite other than what the film was balanced for by the manufacturer.

When it comes to describing the properties of filters, Kelvin temperature breaks down completely. If a given correction filter, for example, alters color temperature 100° with incandescent lamps, the same filter at daylight temperatures may have an effect amounting to three or four hundred degrees!

The first step toward clarification of this muddled situation was the development of a photoelectric instrument which would enable the photographer to measure color temperature instead of guessing it—the Spectra Color Temperature Meter. However, this still left the uncertainty as to the green content of a light source, and made it necessary to consult a table for the selection of a color temperature altering filter.

For more than a year, therefore, extensive work has been done on the development of a simple system to describe and interrelate the properties of light sources, color film and color correction filters by the use of an index number, making description of color of the illuminant as simple as setting an exposure meter with an ASA film speed index.

The first step was the development of a new Spectra, no larger than the previous instrument, which would measure both the blue–red ratio and also the green–red ratio, of any given light source. This is called the Spectra Three-Color Meter (see Fig. 1). The next step was to find a system for the calibration of these two scales that would be simpler, more rational and more informative than the Kelvin scale.

A tentative proposal for such a system was put forward in the paper previously cited,[1] in order to sound out industry opinion on the subject. Comments have been received from scientists, from manufacturers, from cameramen and photographers, and from illumination engineers. Many of their suggestions have been extremely helpful and have been adopted; all were heartily in favor of such a rational system; none favored retention of the clumsy Kelvin temperature scale.

The results of all this have been incorporated in a new index which describes the properties of a light source, a color film or a correction filter, known as the SI or Spectra Index.* This index is derived directly from the mathematical

* This system of indices for light, film and filters is referred to as the Spectra Index (SI) system and where no ambiguity results, Spectra Index (SI) may be used for any one of the individual values. However, where the distinction between light, film and filter is to be denoted, the light index is referred to as Spectra Distribution Index (SDI), the film index as the Spectra Sensitivity Index (SSI) and the filter index as Spectra Transmission Index (STI).

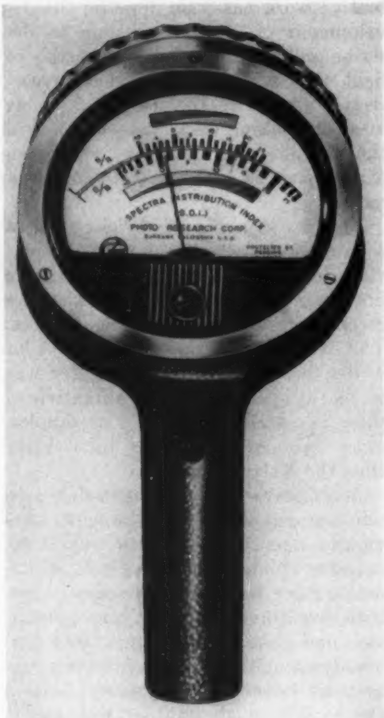

Fig. 1. The new Three Color Spectra Meter.

It reads both the blue–red and green–red balance of the prevailing illumination so that correction can be made for illuminants that fall off the black-body locus, as well as those that are on the locus.

properties of black-body radiation,† and can be duplicated by any manufacturer in any part of the world. It is felt that this step is as important in clarifying a muddled situation as was the original introduction of the Weston film-speed number for use with photoelectric exposure meters.

In the paper presented a year ago, it was proposed that the index be derived from the logarithms of the readings obtained through a special set of standard filters—a method which resulted in a straight-line locus for black-body radiation at all useful Kelvin temperatures, with equal divisions for equal differences of temperature, provided that the latter was expressed in Micro-Reciprocal Degrees (MRD).

However, it has been pointed out that the artifice of the standard filters can be dispensed with, and the index derived directly from the mathematical properties of black-body radiation. If we take Wien's law for black-body radiation:

$$J_\lambda = \frac{C_1\lambda^{-5}}{e^{C_2/\lambda T}}$$

where C_1 and C_2 are the radiation constants;

J_λ is the energy at a given wavelength, λ; and

T is the temperature on the Kelvin or absolute scale;

and take the log of the ratio of the energy at two wavelengths λ_1 and λ_2 then

$$\log_e \frac{J_{\lambda_1}}{J_{\lambda_2}} = A + \frac{B}{T}$$

where $A = 5 \log_e \left(\frac{\lambda_2}{\lambda_1}\right)$

and $B = C_2\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)$. The resulting graph of $\log_e \frac{J_{\lambda_1}}{J_{\lambda_2}}$ against $\frac{1}{T}$ (the reciprocal of the Kelvin temperature) is a straight line.

Carrying this line of reasoning a step farther, it is evident that if the log ratios of one pair of spectral lines, plotted against reciprocal Kelvin temperatures, yield a straight-line graph, then the log ratios of two pairs of lines, plotted against each other, will also

† In the derivation of the units in the Spectra Index system, use is made of the complete spectral distribution of a black body at a given Kelvin temperature and not just to its visual appearance or "color temperature."[2]

yield a straight line, the slope of which may be considered the vector of the rate of change of the two sets of ratios.

This is what has been done in setting up the scale of Spectra Index values. Since Wien's law is substantially valid in the region from 2000 to 10,000 K, it may be considered suitable for dealing with all light sources likely ever to be used in color photography. If desired, a very slight departure from linearity in the upper part of the scales will bring the reading into line with exact temperatures according to Planck's law.

However, taking advantage of the useful mathematical properties of the straight-line locus, two important changes have been made in the index since it was first proposed. First, the logs of the blue–red and green–red ratios have been multiplied by arbitrary constants, so chosen that a difference of 10 MRD in a light source will result in a difference of exactly one unit on the blue–red scale and of one-half unit on the green–red scale. (The reason for the use of the one-half unit will appear in the discussion of correction filters, later in this paper.) Second, for further convenience, a constant has been added to both numbers to bring the index of a 3200 K light source to exactly zero on both scales.

The value of these changes is obvious. Since 10 MRD is generally accepted as the just perceptible difference which will create a visible difference in the resulting color reproduction, the tolerance at any point in the scale becomes one-half unit. Since all light sources used in color photography have a color temperature of 3200 K, or higher, only positive values will normally be encountered. This eliminates the possible confusion of negative indices for illuminants below 4000 K, and positive indices for values above, as first proposed.

The formulas for the conversion of color temperatures to the Spectra Distribution Index and vice versa are extremely simple. They are:

$$SDI_{B-R} = 31.25 - \frac{100,000}{T}$$

$$SDI_{G-R} = 15.63 - \frac{50,000}{T}$$

$$T = \frac{100,000}{31.25 - SDI_{B-R}}$$

$$T = \frac{50,000}{15.63 - SDI_{G-R}}$$

in which

SDI_{B-R} = Blue–Red Spectra Index
SDI_{G-R} = Green–Red Spectra Index
T = Kelvin temperature

In practice, the values for the two ratios are combined, with the blue–red figure coming first; if the B–R value is 5.5 and the G–R value is 2.8, the complete SDI is 5.5/2.8. It will be noted that for equivalent black-body radiation the G–R index must always be one-half of the B–R index (rounded off to the nearest tenth.) If this is not the case, we immediately know that the illuminant in question is off the black-body locus.

The application of the foregoing to color film and to illuminants is immediately apparent. The SDI of an illuminant tells us all we need to know of its properties for trichromatic photography; the SSI of a color film is simply a statement of the illuminant color which will yield the best balanced reproduction on that particular film or coating. This still leaves the question of correction filters to bring the two into balance. This problem has been met in a way which is believed to deserve somewhat extended treatment, since it represents a more comprehensive and systematic approach to the question than any known previous effort.

Consider first the graph shown in Fig. 2 which is the graph of light sources shown as Fig. 10 in the July, 1950, JOURNAL paper[1] now redrafted to fit the new Spectra Index. The illuminants, from A to M, are listed in Table I. This takes in the color space bounded

Table I

	Illuminant	Color	Simplified Filter Designation*	SI or STI†
A.	Studio broadside	4 steps too yellow		
		2 steps too magenta	4 T	4/2
B.	170 M-R lamp with 5070 (Y-1) glass	3 steps too yellow		
		1 step too magenta	3 T	3/1.5
C.	Noon sunlight	3 steps too yellow		
		1 step too magenta	3 T	3/1.5
D.	Whitelite 6300	1 step too yellow	1 T	1/0.5
		1.5 step too magenta	1 G	1/0
E.	Daylight on horizontal plane; fairly clear	Correct	—	—
F.	Same; clear	Correct	—	—
G.	Sun outside the atmosphere	1 step too blue	1 S	−1/−0.5
H.	Graf AC H-I Arc	1 step too blue	1 S	−1/−0.5
I.	Complete overcast	1 step too blue	1 S	−1/−0.5
J.	Whitelite 7100	1 step too blue	1 S	−1/−0.5
		1 step too magenta	1 G	0/1
K.	Illuminant C	1 step too blue	1 S	−1/−0.5
L.	Sunshine Arc, white flame	9 steps too blue	6 S	−6/−3
		2 steps too magenta	3 S	−3/−1.5
			2 G	0/2
M.	North sky, clear	9 steps too blue	6 S	−6/−3
		6 steps too green	3 S	−3/−1.5
			1 M	0/−1

* See footnote on p. 395. † See footnote on p. 388.

by Spectra indices 8 to 24 in the blue–red and 1 to 13 in the green–red. For purposes of orientation, this embraces roughly the color temperatures from 4000 to 15,000 (somewhat more in the green–red), and thus takes in any possible light source which might be corrected for use with daylight type color film.

This graph may be considered rather similar in its properties to the UCS color triangle. As we move upward on this chart, light becomes more greenish; as we move to the *right*, it becomes more bluish.*

* On Judd's Uniform-Chromaticity-Scale (UCS) triangle our two axes would correspond more closely to a line from the right (blue) corner to the middle of the left side (yellow or minus blue) as the B/R axis and the line from the top (green) to the middle of the bottom (minus green or magenta) for the G/R axis. There have been many proposals recommending two axes more or less in the blue–yellow, green-minus-green directions: Adams'[3] uniform chromaticity system, Hunter's[4,5] alpha-beta chromaticity system, and Robertson and Milligan's[6] yellowness–greenness system, to name only three. They seem to have in common at least approximately uniform chromaticity scales with neutral gray as their center and an ease in visualizing the hue represented by given coordinates.

Now, let us set ourselves the hypothetical problem of correcting any illuminant which might be encountered within this color space so that it will give a balanced result on daylight-type color film. If the color of illuminants were a random matter, and we were likely to

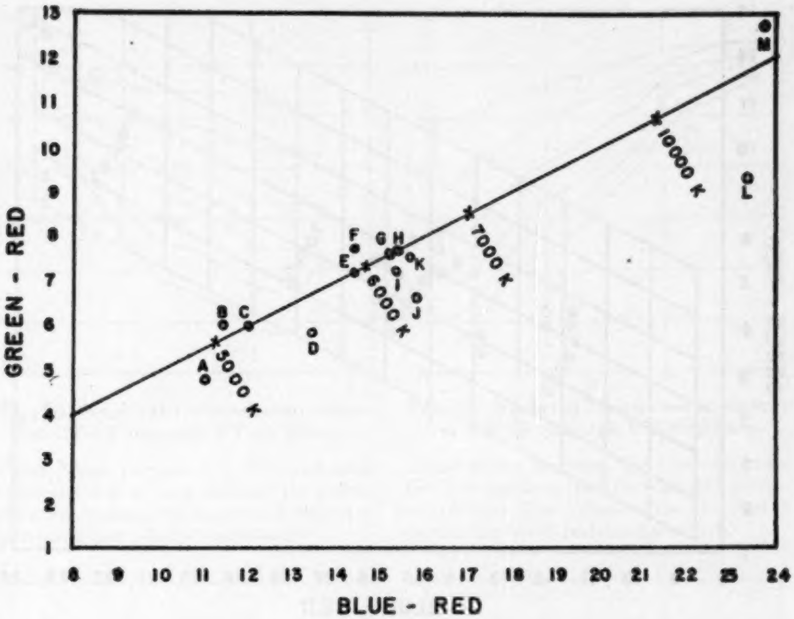

Fig. 2. Thirteen widely assorted illuminants plotted in Spectra Index coordinates.

The diagonal line is the black-body locus. This graph has been redrawn, in terms of the revised Spectra Index values, from Fig. 10 in the Authors' paper in the July, 1950, JOURNAL, p. 85. The illuminants, A to M, are identified in Table I, p. 390.

encounter in practice light sources which fell anywhere within the diagram, then the simplest solution of the problem would be a set of filters which shifted the balance along rectangular coordinates, i.e., a plus- or minus-blue series and a plus- or minus-green series.

However, the color of illuminants is not a random matter. Thirteen real light sources, both natural and artificial, have been plotted in Fig. 2, marked A to M. It will be noted that these light sources tend very strongly to group along the black-body locus. Expressed in another way, the similarities of real illuminants to black-body radiation are greater than the differences. It will be noted that two quadrants of the chart, the upper left and the lower right, which are farthest from the black-body locus, have no illuminants plotted in them at all. For obvious psychological and technical reasons, this is likely to continue to be true. The only illuminants which would fall far from the black-body locus would be highly colored sources, such as the sodium lamp or the old mercury vapor tube, which are not suitable for color photography with any possible degree of correction.

This leads to an important conclusion regarding the problem of correction filters. Since all illuminants tend to be in the neighborhood of the black-body locus, there are obvious advantages in having one set of correction filters so designed that it shifts the hue of an illuminant in the direction parallel to the

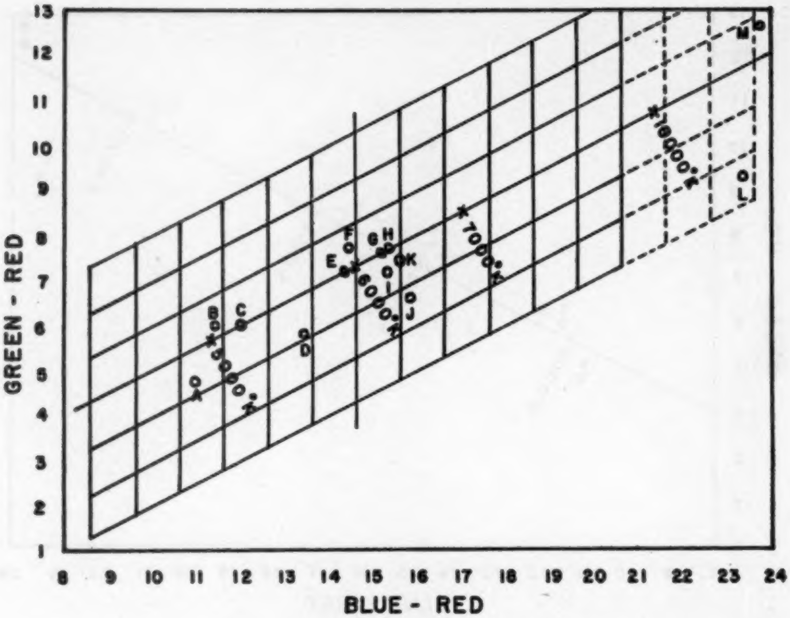

Fig. 3A. The same illuminants as those shown in Fig. 2, with the addition of a grid representing the coordinates of the four series of correction filters, salmon, turquoise, green and magenta.

This grid is not static, but is always shifted so that its O-O point is located at the Spectra Index of the light source being used, and the number of squares that must be traversed to arrive at the SDI of the film (for example, 6000 K, or SDI 14.6/7.3, indicates the filter required). In practice, the entire operation would be carried out, not by means of a graph, but by setting the computer which is illustrated elsewhere.

black-body locus. In a large number of cases, the total required correction can then be made with a single filter.

For this purpose, we require filters with sloping rather than sharp absorptions. Instead of pure yellow (minus-blue) we must use a pinkish yellow which, for each unit of blue which it absorbs will absorb half a unit of green. Instead of a blue, we must use a more greenish hue, having a half-unit of green with each unit of blue. Such a series, of course, is substantially what has been used in the past for the correction of color temperature.

This takes care of the blue–red correction. There remains the question of any additional green–red correction which may be required. Superficially, it might well be assumed that the logical method of accomplishing this would be to use a series of greenish and pinkish filters which would shift illuminant color in a direction perpendicular to the black-body locus. Thus, the filters would be evenly spaced along a series of rectangular coordinates with the entire grid at an oblique angle.

However, a little reflection will show that the logic of this is only apparent,

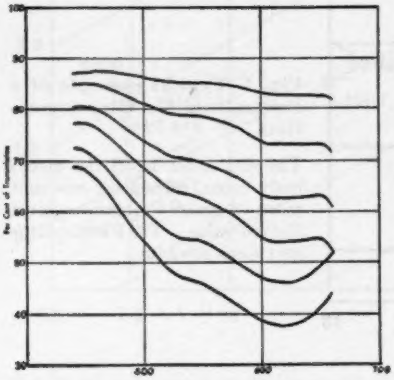

Fig. 3B. Spectral transmission curves for CT-1T through CT-6T filters.

These filters increase the blue–red ratio twice as much as they increase the green–red ratio, so they correct in the direction of increasing black-body temperature.

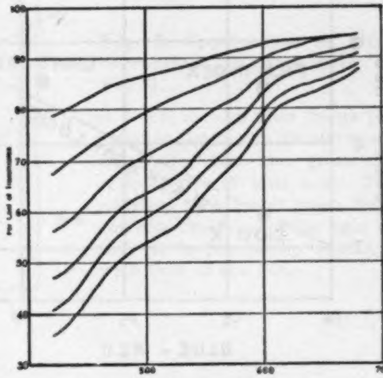

Fig. 3C. Spectral transmission curves for CT-1S through CT-6S filters.

These filters decrease the blue–red ratio twice as much as they decrease the green–red ratio, so they correct in the direction of decreasing black-body temperature.

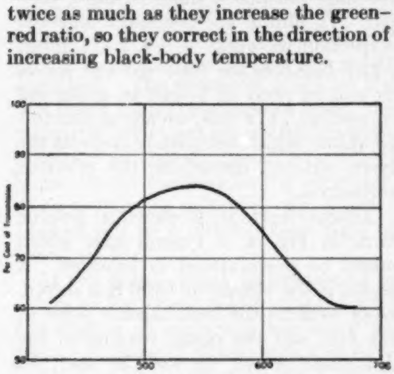

Fig. 3D. Spectral transmission curve for GC-3G filter.

This filter reduces blue and red equally, so increases the green–red ratio only.

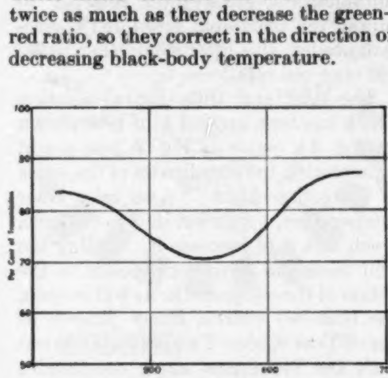

Fig. 3E. Spectral transmission curve for GC-3M filter.

This filter reduces principally green leaving blue–red ratio unchanged but reduces the green–red ratio. Note that GC-3G and GC-3M combine to form a photographic neutral.

and that the drawbacks would outweigh the advantages. Our yellowish and bluish filters affect both the blue–red and the green–red ratios, which is correct and desirable, since it keeps the shift parallel with the black-body locus. However, if we were to use pinkish and greenish filters which shifted the hue at right angles to the locus, then these filters would also affect both ratios. As a result, the choice of the correct filter would become a matter of the greatest complexity. The filter from the salmon–turquoise series which gave the

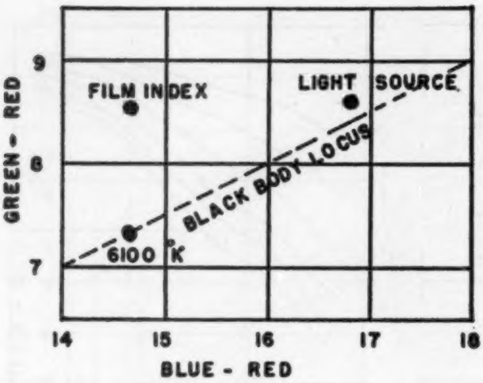

Fig. 4. Typical example of a case calling for filter correction.

The film index is off the black-body locus, calling for one unit more of green than the nearest Kelvin value. The illuminant is two steps too blue.

desired blue–red correction would also shift the green–red ratio. When allowance was made for the latter, and a suitable pink–green filter selected to supply the remaining green–red correction needed, this filter would then upset the blue–red ratio!

The final and truly logical solution which has been arrived at is best shown in Fig. 3A (same as Fig. 2, plus a grid representing the coordinates of the series of correction filters; 6 to raise color temperature, 6 to lower it, 3 to diminish green and 3 to increase it. Sliding the grid back and forth corresponds to the action of the computer.) As will be seen, the blue–red control filters (known as the CT or Color Temperature series) shift the illuminant along coordinates parallel to the black-body locus. The green–red control filters (known as the GC or Green Control series) shift the illuminant along coordinates perpendicular to the graph, which means that they alter the green–red ratio but do not significantly affect the blue–red figure. This releases us from the interdependence of the two filters involved in the previous proposal, and makes the second filter quite independent of the first. (See also Figs. 3B–3E.)

A simple numerical example will indicate how this works out in practice. Let us say that a particular color film has been found to have a Spectra Index of 15/8. The illuminant which we want to use measures not 15/8 but 11/5. This means that we must add 4 units to the blue–red and 3 units to the green–red. To obtain the necessary blue–red correction we apply a +4/2 CT filter, which balances the blue–red and leaves us still in need of 1 unit of green–red correction. For this, we add a plus 0/1 GC filter, which completely corrects the green without disturbing the previous correction.

Another example is shown in graphic form in Fig. 4, a typical case which might be encountered in practice. A region in the vicinity of 6100 K is shown. Dots indicate the best balance point of the film and the meter reading of the illuminant which we wish to use. In this case, we see that the "best balance" point of the film is off the black-body locus, requiring additional green. The illuminant is two steps too blue.

The solution of this problem is shown in Fig. 5. (Addition of a 2-unit salmon filter brings the blue–red ratio to the correct level. This still leaves us 1 unit low in the green–red. The addition of a 1-unit green filter brings film and illuminant into close balance. All of this would be carried out by simply setting the computer.) The application of a −2/−1 filter shifts the illuminant two steps to the left, but also lowers it one square. A second filter, a 0/1, places

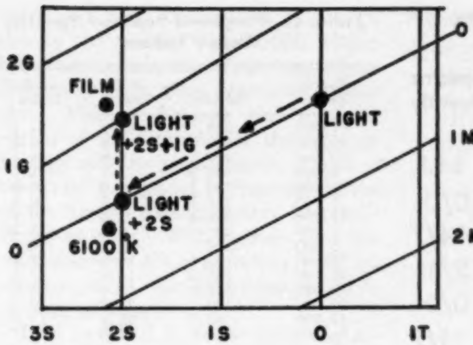

Fig. 5. Application of filter correction to the data of Fig. 4.

A 2-unit salmon filter brings the illumination to the correct blue-red ratio, but the green-red ratio is now 1 unit low. The addition of a 1-unit green filter corrects the index of the light so that it is practically identical with that of the film.

the illuminant very close to the required color balance.*

Actually, none of the arithmetic implied in the foregoing need actually be performed by the user of the meter and filters. A computer has been designed (see Fig. 6) which performs the entire operation. The computer is set for the film index, meter readings are taken, the computer scales are set for the readings obtained, and the required filter or filters appear in the windows on the computer. A card showing values of the Spectra Indices will be published from time to time (see Fig. 7).

At this point, it may be interesting to return to Fig. 3 and summarize the kind and degree of correction necessary for the use of these 13 illuminants with daylight color film. On this chart we assume that we are dealing with a batch of film which is in best balance for an illuminant of 6000 K, or SDI 14.6/7.3. The 13 illuminants would require the filters as listed in Table I to correct them to a film of this balance.

It cannot be too strongly emphasized that the foregoing is not a guide to the correct use of filters. Color film bal-

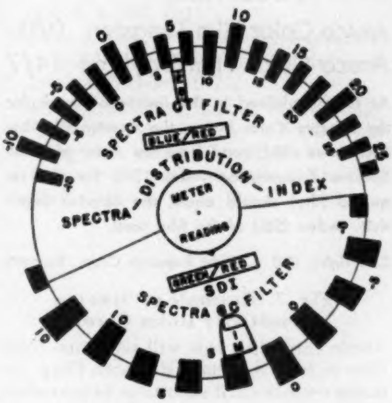

Fig. 6. The computer furnished with the meter.

By means of this meter readings are converted directly into the required filter numbers. Never are more than two filters required to make complete correction.

* For easy identification and to avoid use of + or − symbols which might be overlooked, the filters are marked as follows: Positive CT filters, B–R ratio followed by "T" for turquoise; Negative CT filters, B–R ratio (sign omitted) followed by "S" for salmon. On the CT filters, G–R ratio has been omitted since it is always 1/2 of the B–R ratio. Positive GC filters are marked with the G–R ratio followed with "G" for Green, and, negative GC filters marked with G–R ratio (sign omitted) followed by "M" for Magenta. Since the B–R ratio is always zero for GC filters it is omitted from the marking.

SPECTRA SENSITIVITY INDEX
(SSI)

The following table shows the Spectra Sensitivity Index (SSI) for currently available color films:

EASTMAN FILMS	S.S.I
Ektachrome Type B	0/0
Ektachrome Daylight	14/7
Kodachrome Type A	2/1
Kodachrome Type B	0/0
Kodachrome Daylight	14/7
ANSCO FILMS	
Ansco Color Film Tungsten	0/0
Ansco Color Film Daylight	14/7

As fully explained in the instruction book for the Spectra Color Meter, the Spectra Distribution Index (SDI) read from the meter plus the Spectra Transmission Index (STI) for the required filter should equal the Spectra Sensitivity Index (SSI) of the film used.

Copyright, 1950 Photo Research Corp., Burbank

Fig. 7. Example of Spectra Sensitivity Index Card.
Triple cards like this will be issued from time to time by Photo Research Corp. for meter owners until such time as manufacturers may mark the Index on each package of film.

anced to a different hue would alter all of the values; also the illuminant values are mainly isolated examples, and the same illuminants might yield widely different readings in other cases.

For those interested in the equivalence of Spectra Indices to Kelvin temperatures, without the labor of computing them, Table II has been prepared.

In Table II, values marked with an asterisk correspond to the indices most useful in connection with color photography. Consider, for example, Type A film used with Photofloods. The Spectra Index is 1.8. (Actually, the full Spectra Index is SI 1.8/0.9, indicating

Table II. Proposed Scale of Spectra Index Values

Kelvin Temp.	MRD	B–R Index	G–R Index
1,000	1,000	−68.8	−34.4
2,000	500	−18.8	−9.4
2,500	400	−8.8	−4.4
3,000	333.3	−2.1	−1.1
*3,200	312.5	0.0	0.0
3,250	307.7	0.5	0.3
*3,400	294.1	1.8	0.9
4,000	250	6.3	3.2
5,000	200	11.3	5.7
*5,900	169.5	14.3	7.2
*6,100	163.9	14.9	7.5
7,000	142.9	17.0	8.5
10,000	100	21.3	10.7
12,000	83.3	22.9	11.5
Infinity	Zero	31.3	15.7

both the blue–red and green–red values. Since, however, the two are identical for equivalent black-body radiation, the one index number is sufficient. If light (daylight, for example) has no black-body equivalent, the double index number must be employed. The same is true of color film when not balanced to an equivalent black-body radiation.) This becomes the index of the color film, and we also know that the lamps we are using should read 1.8 on the B–R scale and 0.9 on the G–R scale, or *within one-half unit* thereof. In other words, the Spectra B–R scale should not be below 1.3, or above 2.3. If it is, a suitable filter must be used to bring it within one-half unit of 1.8. Similarly, if the G–R scale is below 0.4, or above 1.4, a filter is needed.

Many of the light sources which do not depend on thermal radiation for their radiant energy have rapidly changing spectral distribution curves and may have wavelength regions where practically no energy is being radiated (e.g., Cooper-Hewett lamps, sodium vapor arcs, etc.) However, if sufficient energy is present in all three of the blue, green and red regions so that the Spectra Indices may be determined, then the filters indicated will make gray objects reproduce on the film as gray and will be the best all-around color reproduction that can be made with that

light and film combination, although due to the uneven distribution within the zones certain colors may reproduce differently than they appeared to the eye. This is because the response curves of the film are not the same as the eye and the photographic model of the meter is adjusted to response curves of the film so that gray may be reproduced as gray. With sources that are continuous in their radiation with no sudden peaks, the matching is quite close in all colors.

It is believed that the foregoing results in a system which is as simple to use as an exposure meter. It is hoped that manufacturers of color film and filters, and others, will use the proposed system and favor its adoption as a standard.

Until the system is adopted by others, tables of indices will be provided for the use of existing material now calibrated on the old system, or users of the meter can easily calibrate batches of film to their own particular taste.

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A Rapid-Action Shutter With No Moving Parts

By Harold E. Edgerton and Charles W. Wyckoff

The Rapatronic* camera takes still exposures of 2 to 20 μsec with a high degree of resolution. Exposure is easily synchronized with a fast-transient event, and the shutter has at least a 30-deg viewing angle with apertures in the useful range for high-speed photography. The shutter is of the magneto-optic "light valve" type, operating by the rotation of the plane of polarization of light traversing glass in a magnetic field (Faraday effect). Three polarizers, crossed at 0–90–0 deg, produce an open-to-closed transmission ratio in excess of thirty million, and removal of the magnetic field closes the shutter, allowing it to pass only one billionth of the light from the subject.

THE NEED FOR a shutter whose speed of operation is not limited by mechanical moving parts has long existed. One such shutter is the Kerr Cell type. Another type is the magneto-optic shutter. This article describes an improved model of the latter wherein several operating features have been modified.

Several motives were present when the development of the magneto-optic shutter described here was started. First, a short exposure was required. Second, a wide-viewing angle capable of accommodating the usual photographic recording methods was needed. Third, a large ratio of open-to-closed light transmission was important. Fourth, a system capable of high resolution of the optical image was desired. Fifth, a triggering system of an electrical nature where photoelectric signals could actuate the shutter was necessary. All of these objectives were realized by the shutter and control circuits of the Rapatronic camera.

With this shutter, a series of problems wherein the subject is selfluminous can be studied successfully in two possible ways. The most obvious one is the use of the selfluminosity itself for producing the exposure. Few subjects other than explosives have enough instantaneous luminosity to be photographed by their own light. A few examples are included to show the results of such applications. A second use of the shutter is to exclude the light from a luminous subject until light from an electronic-flash tube illuminates the subject for a photograph. An example among the illustrations shows a silhouette photograph of a firecracker explosion. The

Presented on October 19, 1950, at the Society's Convention at Lake Placid, N. Y., by Harold E. Edgerton, Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass., and Charles W. Wyckoff, Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston, Mass.

**RAP*id *A*ction elec*TRONIC* shutter.

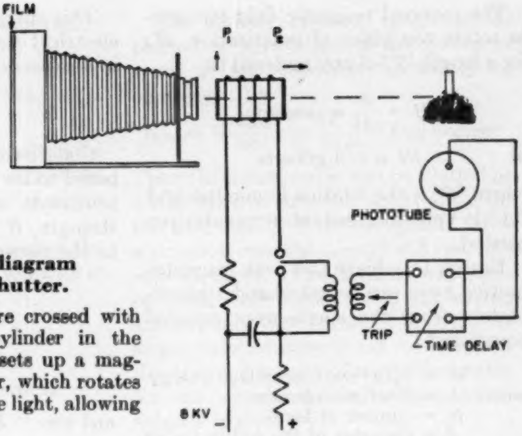

Fig. 1. Elementary diagram of the Rapatronic shutter.

Polaroid discs, P_1 and P_2, are crossed with an extra-heavy flint-glass cylinder in the center. Current in the coil sets up a magnetic field in the glass cylinder, which rotates the plane of polarization of the light, allowing transmission.

magneto-optic shutter excluded the light from the explosion but was timed to be open when the electronic flash occurred.

The "Rapatronic" shutter, as we have called it, appears to be a very useful tool for high-speed photography. Its unusually good open-to-closed ratio, its wide-angle optical system, its short exposure time, its controllability and its rugged practical nature make it a device that will find many applications on problems where bright lights and short exposure times are important.

Theory of Operation

The physical arrangement of a simple single-element magneto-optic shutter is shown in Fig. 1. Two Polaroid discs are shown at P_1 and P_2 in a crossed position so that no light is passed. Between the Polaroid discs is a glass element, or other material, which rotates the plane of polarization as a function of the magnetic field strength.

For a shutter of practical dimensions, the magnetic field strength for complete opening is very high. One practical method of obtaining such large field strengths is by the condenser-discharge method as illustrated in Fig. 1. Here electrical energy is stored in a capacitor at high voltage so that it can be rapidly discharged into the coil around the optical element whenever a signal is received, for example, from the photocell of Fig. 1.

The Faraday Effect

The plane of polarization of a beam of light in a magnetic field and parallel to the lines of force, is rotated according to the following relationship:

$$\theta = AlH$$

θ is the angle of rotation;
A is the Verdet constant;
l is the length of path of the beam in the magnetic field; and
H is the intensity of the field.

The Verdet constant of several likely materials for optical shutters is given below:

Substance	*Verdet's Constant, min/oersted*
Water	0.0130
Benzine	0.0297
Carbon disulfide	0.0441
Glass, Crown	0.0203
Flint	0.0420
Flint, dense	0.0647

The above data was measured with sodium light at 5893 A. Selected from *Handbook of Chemistry and Physics*, Chemical Rubber Publishing Co.

The required magnetic field strength to rotate the plane of polarization, H, for a length "l" of any material is:

$$H = \frac{\theta}{Al} = \text{oersteds}$$

or $$Hl = \theta/A \text{ gilberts}$$

where "θ" is the rotation in minutes and "A" is Verdet's constant in minutes per oersted.

Energy to achieve this peak magnetomotive force can be calculated approximately from the single-layer solenoid equations*:

$$W = \tfrac{1}{2}LI^2 \text{ watt seconds of energy}$$

where $L = N^2dF$ microhenries
N = number of turns
d = diameter of the coil in inches
F = a constant = .0071 for $\frac{\text{length}}{\text{diameter}} = 3.$ with d in inches

$$W = \frac{F}{2}\, d\,(NI)^2 \times 10^{-6} \text{ watt seconds}$$

*Frederick E. Terman, *Radio Engineering*, p. 14, McGraw-Hill, New York (from National Bureau of Standards Circular 74, *Radio Instruments and Measurements*).

This energy can be obtained from an electrical capacitor. The energy stored in a capacitor, C, charged to E volts is:

$$W = \frac{1}{2}\, CE^2 \text{ watt seconds}$$

Considering the coil to be long compared to its diameter, the following approximate equation relates the field strength, H, at the midpoint of the coil to the current.

$$H = \frac{4\pi}{10}\ \frac{NI}{1} \text{ oersteds}$$

or $$Hl = \frac{4\pi}{10} NI \text{ gilberts}$$

and also $$Hl = \frac{\theta}{A} \text{ from before}$$

from which $$I = \frac{\theta}{AN}\ \frac{10}{4\pi} \text{ amperes}$$

and $$W = \frac{Fd}{2}\ \frac{\theta^2}{A^2}\left(\frac{10}{4\pi}\right)^2 \times 10^{-6} \text{ watt seconds}$$

This same energy is required in the capacitor assuming no losses. There-

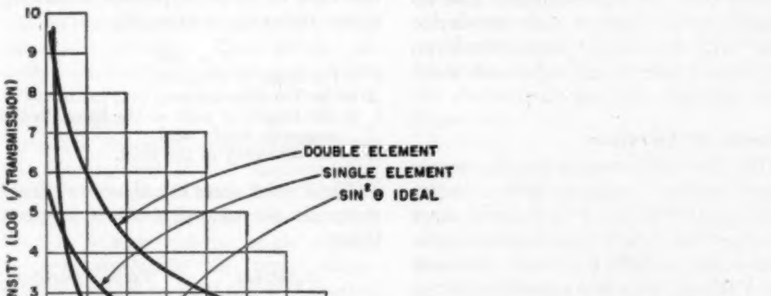

Fig. 2. Density of an ideal single shutter with sine squared relation compared to measured density of a practical single and double system. The double shutter tested has two 15-mm lengths of lead glass, three HN23 polarizers, a minus-blue and a minus-infrared filter. The single shutter lacks the center polarizer.

fore the size of the capacitor theoretically will be:

$$C = Fd\frac{\theta^2}{E^2A^2}\left(\frac{10}{4\pi}\right)^2 \times 10^{-8} \text{ farads}$$

The actual capacity required will be more than this since all the energy in the capacitor does not reach the space where the rotation occurs.

The half-cycle time of discharge of the capacitor into the shutter coil inductor is approximately:

$$T = \pi\sqrt{LC}$$

$$= FdN\,\frac{\theta}{EA}\,\frac{10}{4} \times 10^{-4} \text{ seconds}$$

and $\omega = 1/\sqrt{LC}$ radians per second

From the above equation for the half-cycle time of discharge, the duration of the opening time and the transmission can be estimated for any specific example. Note that the time is directly proportional to the number of turns in the coil and inversely proportional to the initial voltage to which the capacitor is charged.

The light transmission of a single magneto-optic shutter is a sine squared function of the rotation angle, θ, if the polarizers are ideal and crossed. The transmission of practical shutters is shown in Fig. 2. Thus when $\theta = 90°$, the transmission is a maximum. Any further rotation will decrease the light transmitted. From a practical standpoint, it is not necessary to achieve the 90° rotation since a smaller angle produces almost as much transmission. The angle for an 80% transmission is 63.5°. This maximum rotation is ample for most purposes.

From the above equations, the preliminary design for a specific shutter for a given diameter, d, or a given exposure time can be accomplished. The actual circuits will have additional inductances in the capacitors and wiring and these must be considered, especially for short exposure times.

The shutter opening cycle can be plotted as a function of the discharge cycle of the capacitor assuming no damping. Let

$$\theta_{max} = \frac{AH_{max}l}{60} = \frac{4\pi}{10}\,\frac{A}{60}\,NI_{max} \text{ degrees}$$

Then the transmission can be plotted as a sine squared function of the angle for the first half-cycle of oscillation. For a practical case the current will oscillate several times. The shutter will open on each half cycle by a decreasing amount until the transient is over. A single pulse of current can be obtained if a damping resistor of the critical value for the circuit is used. Such a resistance is given by:

$$R = 2\sqrt{\frac{C}{L}}$$

where this resistance is the effective total resistance of the entire circuit. The peak current for the critically damped case is about half of the current peak for the undamped case. Therefore, the peak light transmission will be decreased when a damping resistor is inserted in the circuit.

To obtain compensation for the effect of damping, either additional capacity or a higher voltage can be used.

The connecting wires and the internal inductance of the capacitor will be very important for the above example since the coil inductance is so small. The results must be modified for such cases in accordance with electrical circuit theory.

The current in the coil will normally oscillate for several cycles if no damping resistor is used. For each current surge, regardless of polarity, the shutter will open on the peak. Each opening will be less than the preceding, since the peak current is less. A damping resistor of the critical value for the circuit will prevent these subsequent shutter openings. However, the peak current for the first peak is reduced in value unless a larger capacitor or a higher voltage is used.

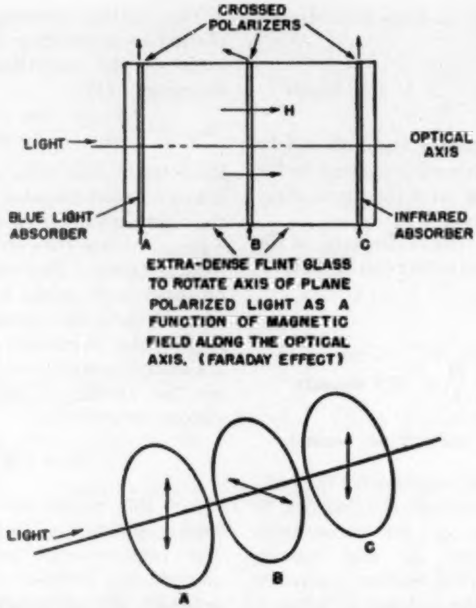

Fig. 3. Double Rapatronic shutter with three Polaroid discs and filters. The entire assembly is cemented together in a single unit. The advantage of the double combination is a very opaque closed condition permitting the photography of very bright subjects.

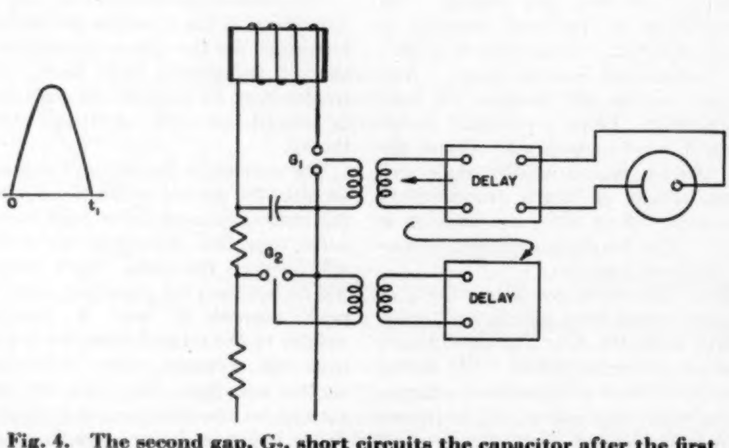

Fig. 4. The second gap, G_2, short circuits the capacitor after the first half-cycle of oscillation to limit the opening to a single operation.

Fig. 5. A photograph of a firecracker during the explosion.

A 2-μsec electronic light source produced the illumination to expose the photograph. The light from the firecracker explosion was excluded by the use of a Rapatronic shutter.

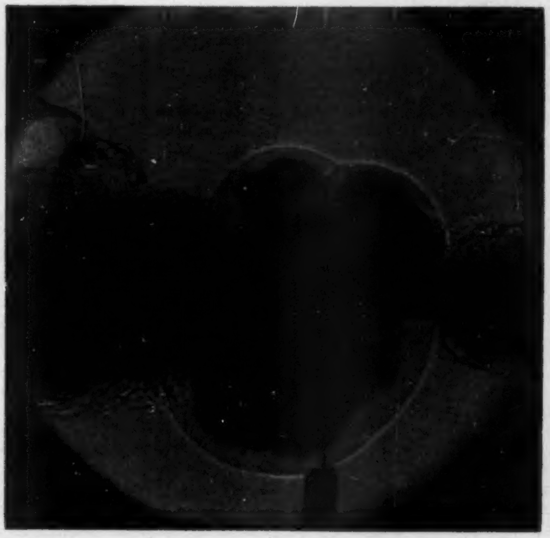

Fig. 6. A silhouette photograph of a firecracker at the instant of explosion.

The exposure time is about 1 μsec. A field lens is placed back of the firecracker to concentrate the light from a spark into the camera lens. A Rapatronic Shutter was used to exclude the light from the explosion of the firecracker.

Another method of obtaining a single surge is illustrated in Fig. 4 where a second gap short-circuits the capacitor at the end of the first half-cycle. A time delay and a trigger circuit are shown which accomplish the correct timing. The method of Fig. 4 is used when short exposures are desired.

Triple Polaroid

The use of a third Polaroid film as shown in Fig. 3 greatly helps the closed density of the shutter due to the series action of the triple crossed polarizers. However, about four times as much electrical energy is required if the total length of the glass optical path in the shutter is the same as with the two-Polaroid shutter.

Typical conditions for a three-Polaroid shutter 1½ in. long and 1 in. in diameter are:

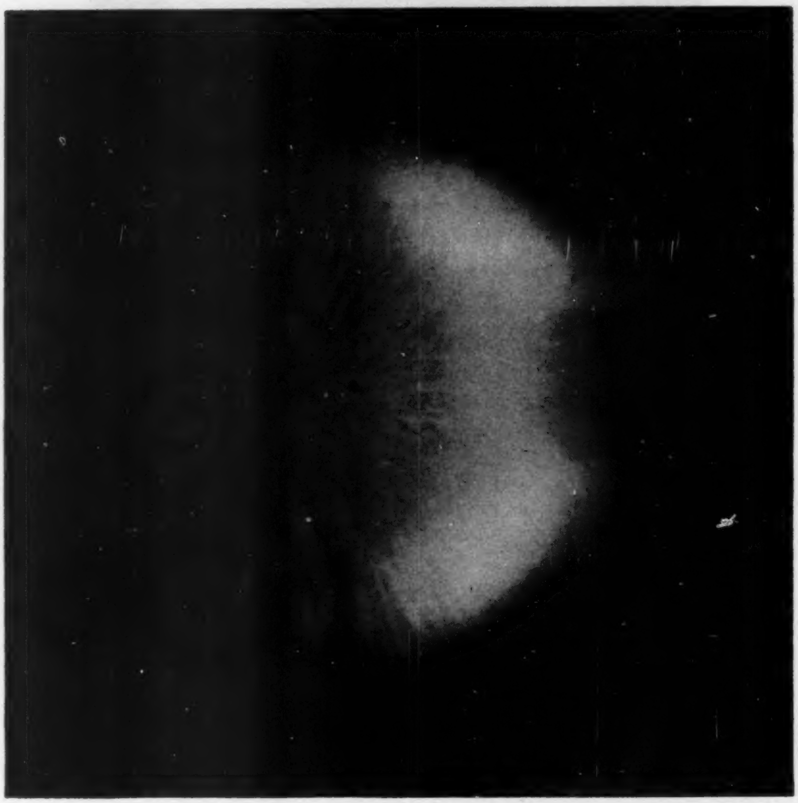

Fig. 7. The explosion of a 6-in. stick of high explosive (Pentolite).
The light from the explosion was picked up by a photoelectric cell which in turn opened a Rapatronic Shutter for 4 μsec, catching the explosive wave about halfway through the stick.

Fig. 8A. A self-exposed 4-μsec exposure of the explosion timed 15 μsec after the light triggered the phototube.

The scale is the same in Figs. 8a and 8b. Note the relatively dark areas that were the corners of the cube. This effect is the opposite of the Monroe effect.

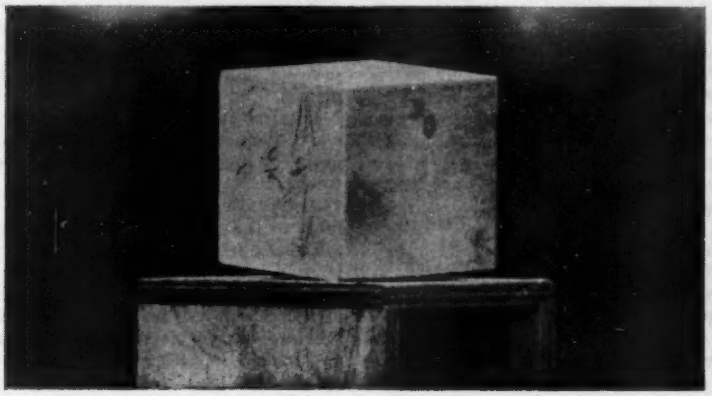

Fig. 8b. A cube of high explosive, four inches on a side, before being detonated at the center of the base.

Coil turns = 6.5
Capacity, C = 4 microfarads
Voltage, E = 8000

$$\frac{\text{Transmission } (\theta = 0)}{\text{Transmission } (\theta = 30°)} = 10^7$$

Closed density greater than 10^9
Half-cycle time = 6 μsec
Effective exposure time = 3 μsec

Examples

Two types of Rapatronic photography are shown in the illustrations:

1. Where the Rapatronic shutter excludes the light from the subject except for a brief exposure by auxiliary flash lighting (see Figs. 5 and 6).

2. Where the Rapatronic shutter exposes a photograph with light from the subject. Only subjects that emit intense instantaneous light can be studied in this manner. (see Figs. 7, 8a and 8b).

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Discussion

Anonymous: Can the camera be focused with the shutter in the optical system and if not, does any compensation have to be made by removing the shutter?

Mr. Wyckoff: A camera employing the double-system shutter cannot be visually focused with this shutter in the optical path. A corrected focusing scale can be determined either by a series of approximation photographs or by calculation of the light-path difference due to the amount of glass added to the optical system. If the shutter is placed in front of the lens it can be very easily removed to permit a visual focus. When used in this manner with a short focal-length lens with a subject distance of several feet, compensation is not necessary.

A single-system shutter can be made so that one polarizer is physically rotatable. The shutter can thus be made to be transparent or "open" for a visual focus. The unit we are demonstrating today is the double system and cannot be made transparent for focusing because all three polarizers are securely cemented to the glass.

Anonymous: I would like to ask Dr. Edgerton if the material used is the standard polarizer produced by Polaroid Corporation similar to that for use in sun glasses.

Dr. Edgerton: No. This material is one of the newer Polaroid products known as H for high density and N for neutral color.

Anonymous: Have you found any limit to the physical size of the shutter?

Dr. Edgerton: We have not experimented with shutters larger than one inch in diameter. However, we see no reason for not making larger shutters except for the size of the electrical energy-storage equipment.

A-C Magnetic Erase Heads

By M. Rettinger

Various types of a-c magnetic erase heads of the ring-shaped type are described. After a brief mathematical treatment of the magnetic flux density required for erasing, there are given the measurements of the amount of erasure obtained with various heads used both singly and in cascade. Also included are curves showing the rise in temperature on part of two heads as a function of the 70-kc erase-current through the head.

The method of a-c erasing consists in passing the recorded medium through an alternating magnetic field which, in its central portion, has a high enough flux density to saturate the medium, and which, outside the central region, decays gradually to zero. The necessary extent of the field, both in its center and in its adjoining regions, is dependent on the wavelength of the erase frequency, in order to assure a sufficient number of magnetic reversals while the medium is passing over the eraser. This wavelength, in turn, is dependent on the speed with which the medium travels, and is given by:

$$\lambda = \frac{V}{F}$$

where λ = wavelength, inches;
F = frequency, cycles per second; and
V = speed of medium, inches per second.

Thus, for a 68,000-c erase frequency and a medium speed of 18 in./sec, the wavelength comes to 18/68,000 = 0.000265 in. In the case of a 0.004-in. long central field, every portion of the medium in its passage over the eraser is subjected to approximately 15 magnetic reversals (0.004/0.000265).

So-called ring-shaped heads are, at present, the preferred type of erasers. Like ring-shaped record and reproduce heads, they consist usually of two laminated cores forming a toroid of a sort, with a back and a front gap. The material for the laminations is most frequently silicon steel because of its higher saturation point, compared to Mumetal or Permalloy. The lamination thickness is kept very small, 0.003 in. or less, to reduce to a minimum eddy current losses with their consequent heating effects. While the front gap may assume various configurations, including that of a double gap, the back gap generally consists of a butt joint, since, on account of the large front-gap reluctance, no demagnetizing back-gap spacer is required, unlike in a recording head.

Figure 1 shows various types of ring-shaped erase heads. In this figure, (a) represents the most commonly used unit; it may be noted that in the German Magnetophon[1] the front gap had a com-

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Presented on October 18, 1950, at the Society's Convention at Lake Placid, N.Y., by M. Rettinger, Engineering Products Dept., RCA Victor Div., 1560 N. Vine St., Hollywood 28, Calif.

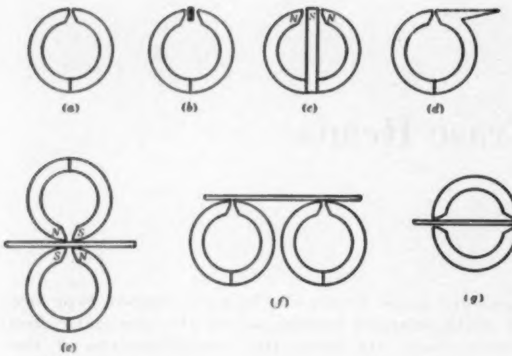

Fig. 1. Various types of ring-shaped erase heads.

paratively great length, 0.5 mm (0.020 in.). The second head shown, (b), employs a double gap,[2] consisting of a magnetic spacer sandwiched between two plastic spacers. The head pictured in (c) also has a double gap, but utilizes a magnetic center core instead of a magnetic center spacer as shown in (b). Figure 1(d) shows a head used in connection with d-c erasing. Figure 1(e) is a dual head in which the tape passes between two "standard" erase heads. In (f), the tape passes first over one and then over another erase head; this unit will be described in greater detail later. Figure 1(g) represents the "Howell head," intended for high-coercivity tape, and energized with power-line frequency current, according to patent claims.[3]

For a given front-gap length of head, two factors appear to favor a high erase frequency. The first is the increased number of magnetic reversals to which the tape is subject as it passes over the head. The second is the greater amount of self-demagnetization on the part of the little "dipoles" on the tape. The disadvantage of a high erase frequency rests chiefly in the larger eddy-current losses, with their consequent heat production and power waste, which losses increase with the square of the frequency. The flux density in the air gap is given by

$$H = \frac{\phi}{A} = \frac{\text{mmf}}{R}\,\frac{1}{A} = \frac{0.4\pi NI}{\frac{l}{A}}\,\frac{1}{A} = \frac{0.4\pi NI}{l}$$

where ϕ = flux, maxwells;
A = area of pole face, in square centimeters;
R = reluctance of air gap (considered much larger than the reluctance of the core, so that the latter becomes negligible);
N = number of turns;
I = current, amperes;
l = length of air-gap; and
mmf = magnetomotive force, gilberts.

When $N = 180$, $I = 0.075$ amperes, $l = 0.01$ cm (0.004 in.)

$$H = \frac{1.256 \times 180 \times .075}{0.01} = 1695 \text{ gauss.}$$

Investigating, at 70 kc (kilocycles), the ratio of flux density in the front air gap to that at the periphery where the tape rides, Fig. 2 was obtained. As may be surmised, this ratio decreases with increasing gap length, and has a value of 4 for a front-gap length of 4 mils. The relatively high flux density in the air gap compared to the peripheral density has led various investigators to construct erase heads in which the tape passes through the gap, as in the "Howell head," and as in the device shown in Fig. 1 (e). The unfortunate

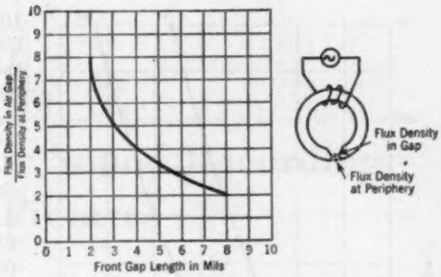

Fig. 2. Ratio of flux density in the front air-gap to that at the periphery as a function of front-gap length.

feature of these "tape-through-gap" heads lies in the relatively large gap which must be employed, since it must be large enough to pass a splice. Needless to say, such heads must be rigidly constructed if they are to be tuned, since small changes in the gap length will produce large changes in the inductance, with consequent tuning variations.

To learn something of the effectiveness of high-frequency erase heads of the ring type, a number of pairs of heads were built with different front gaps and identical inductances. The value of inductance chosen was 2 mh (millihenrys), so that two heads in series would have an inductance of 4 mh, which with a series tuning condenser was considered the largest practical value for an erase frequency of 70 kc. For a single head and short leads, the series capacity was 0.0026 μf (microfarads), and for a double head, 0.0013 μf. The back-gap spacer of all heads was made of the same material as the core laminations (4% silicon steel), and its length was equal to that of the plastic front-gap spacer. The recording medium used was Minnesota Mining Company 35-mm film, No. 115.

A number of tests made with single heads indicated that, regardless of the current supplied to the head, 70-db erasure was not possible. Surprisingly, a head with a 20-mil front gap erased about as well as one with a 4-mil gap. All heads erased 50 db with 100 ma (milliamperes), and 57 db with 120 ma, after which additional current had little effect. A head with the double gap such as shown on Fig. 1(c) provided 61-db erasure with 120 ma, after which additional current had again little effect.

When two heads were connected in cascade, however, so that the tape had to pass first over one and then over the other, the heads with the 4-mil gaps were much more effective than those with the 20-mil gaps. Thus, the "4-mil heads" provided 70-db erasure with only 70 ma, two "10-mil heads" required 100 ma, and two "20-mil heads" needed 120 ma of current for this amount of erasure.

A rather stringent erase test is made not merely to note the output meter of the reproduce amplifier during erasing, but also to listen to the monitoring speaker, with full gain in the reproduce amplifier while erasing a 1000- or 2000-c test frequency to which the ear is most sensitive. Thus the output meter might indicate complete erasure, or at least show a value comparable to that obtained when the tape is erased with a 60-c Goodell eraser; yet, when high-frequency erasure is incomplete, a trace of the test frequency can still be heard, so that the current through the head has to be increased until the signal is no longer audible. The effectiveness of all of the experimental heads was therefore judged not only by the output meter but also by the ear.

To investigate the subject further, one 4-mh head with a 4-mil front gap was built. While it was possible to erase 68 db with this head when a cur-

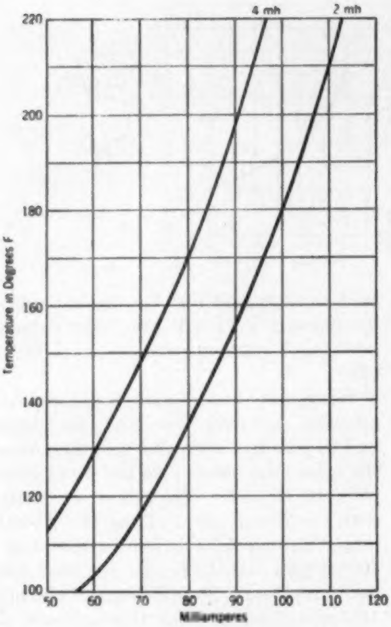

Fig. 3. Temperature rise of the head cores as a function of current.

rent of 120 ma was flowing through it, the head became undesirably hot. It may be noted that, if the chief determining factor for erasing had been the number of ampere-turns, the 4-mh head, with its 1.41 times the turns which each of the 2-mh heads carried, (Fig. 1(f)), should have erased equally well with 1.41 times the current which flowed through each of the two 2-mh heads, or approximately 100 ma (.07 × 1.41).

It was at first believed that the 4-mh head, with its larger number of ampere-turns, became saturated when a current of 100 ma or somewhat larger was flowing through it. For this reason a small exploring loop made of 0.001-in. wire was placed in front of the gap, and the output from the loop amplifier was noted as the head current was increased from 10 to 200 ma. Perfect linearity existed for this current range between input to the head and output from the loop amplifier at 68 kc; nor did the flux distribution about the gap widen or change for these current values.

For this reason it may be possible that, after first erasing the tape with a ring-type head energized with high-frequency current, there occurs a "reawakening" of the signal—a reorientation of the dipoles constituting the signal on the tape—which can be completely obliterated only by a second erase operation.

Apparently, too, some time lag must exist between the two erase operations. For this reason, possibly, the double-gap head with its 0.1-in. center core, providing a time interval of only 1/180 sec, was not as effective as the two heads in cascade, whose separation corresponded to a time interval of nearly 1/10 sec. Further study of this method of erasing appears, therefore, desirable.

A definite advantage connected with the use of two heads in cascade lies in the reduced heating of the head occasioned by the smaller current required for each head to effect complete erasure for the two. Figure 3 shows the temperature rise of the head cores as a function of current (70 kc). The curve was obtained by placing a thermocouple on the cores at the point where the tape contacts the head, and increasing the current in 10-ma steps at 10-min intervals.

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2. J. G. Frayne and H. Wolfe, "Magnetic recording in motion pictures," *Jour. SMPE*, vol. 53, (p. 225) pp. 217–235, Sept. 1949.
3. U.S. Patent No. 2,498,423 (1950).

A German Magnetic Sound Recording System in Motion Pictures

By Martin Ulner

Contrary to corresponding developments in the United States and Great Britain our starting point was to employ the magnetic-sound technique in the studio until the final re-recording on sound negative film. We did not take the necessary equipment from the optical recording system, but developed new equipment for magnetic film; and we retained the 6.5-mm magnetic tape for original recordings because of its economy.

Of the advantages of the magnetic recording procedure, that of economy is the most important in Germany. The cost of sound recording material for magnetic film is 0.23 DM (Marks) per meter, compared with 1.10 DM for an optical sound print. In the interests of economy it was decided from the beginning to use 17.5-mm split magnetic film which has no disadvantages over the 35-mm magnetic film if the film drive mechanisms are properly constructed.

Since 1945 every German film studio has made all original sound records on 6.5-mm magnetic tape and has been re-recording the good takes (in most cases immediately at the end of the recording, or at the latest on the evening of the same day) on optical film. The customary German tape recorders (of the firms AEG and Opta) are so constant in their speeds that for normal takes synchronism is maintained up to almost 60 m; the deviation for ten minutes' running time is at most four frames. Methods for synchronizing the 6.5-mm tape have indeed been developed in Germany, but have never been brought into use.

The method of working with perforated magnetic film was first introduced by the Tempelhof Film Studio in the Spring of 1950, so that now the optical sound film is employed only in re-recording on the final negative. Since then other studios have adopted the magnetic film recording method as used in the Tempelhof Studios. This procedure has proved quite successful.

All apparatus has been developed and built in the Tempelhof Studios. The development of the new equipment was not based on the optical sound recording apparatus already in use, but was developed to suit the method of working at this studio.

The Working Method

To guarantee maximum economy, all original records are re-recorded on 6.5-mm tape which costs 12.00 DM compared with 70.00 DM for the magnetic

A contribution submitted on February 5, 1951, by Dr. ing. Martin Ulner, Filmstudio Tempelhof of the Universum-Film A.G. (formerly UFA), Berlin-Tempelhof (U.S. Sector of Berlin), Germany.

film for ten minutes' recording time. This method of retaining the 6.5-mm tape as a safety has an advantage in that this tape can be stored until the completion of the picture in case something happens to the magnetic film. At the same time the magnetic tapes can remain uncut and can be erased and reused after the completion of the film.

For feature pictures the print-takes (i.e., approximately one-fifth of the length) are re-recorded again, this time on 17.5-mm magnetic film, immediately after the recording as it was done before on the optical sound film. For advertising, documentary and cultural films and for dubbing of foreign films it has been found that only a single recording was needed.* One magnetic film is sufficient for the working print, for the editing, for the review and for the final re-recording print.

To simplify the cutting, the sound waves are registered visibly on the recorded magnetic film which is then forwarded to the editing room. After the recording, the magnetic film is cut and synchronized to the picture film and ready for daily running (review). After the first assembly of a dialogue reel comes the second cutting, after which it is ready for re-recording on the final negative. As already stated, in dubbing of foreign films the first magnetic film serves for the re-recording. Other magnetic film rolls contain the music and the sound effects. Optical sound reels, for example library music and sound effects, can, of course, be mixed in.

Magnetic Sound Film Recording Equipment

Figure 1 shows the magnetic sound recorder and Fig. 2, the (general) assembly of the recording equipment including monitoring. The mechanism of the magnetic sound recorder is driven by a 220-v, a-c, 50-cycle, three-phase synchronous motor. In Germany the picture camera and the sound recorder are supplied by the 50 cycles net. Synchronization is done by the old-fashioned clapstick (which has proved to be the best). Also in dubbing work the picture projector and the sound recorder are supplied by the same 50 cycles net. In the sound track the commencement of the picture loop contains so-called bloops (blumpers, clicks) or short a-c signals. These are recorded and serve for synchronizing. When shooting on location the power supply for the picture camera and the sound recorder comes from an a-c–d-c unit or inverter. In the recorder (Fig. 1) the magnetic film is transported by a 32-tooth sprocket (1). Film stabilization is controlled by a filter of two pivoted rollers (2 and 3), a large flywheel on the shaft of the primary sound drum (4) and a small flywheel on the shaft of the secondary sound drum (5). In order to keep the film from becoming mechanically damaged, the large flywheel, which is at the start coupled with the motor, is driven until it has gained full speed and is then uncoupled automatically.

The recorder and the pickup head are mounted between the two sound drums so that the recorder head is right next to the primary sound drum (4) with the playback head just behind it. The shields (6 and 7) are situated on the other side of the film. A special feature of this construction is that, when threading the film, only the head support (8) with the two magnetic heads will be lifted. During the process of reloading and rewinding, the withdrawal of the head support is not so far but that a certain amount of induction still takes place in the reproducer head so that when rewinding is in progress the signal can still be heard. This simplifies the refinding of different takes. Because the

* Dubbing of foreign films in German is done exclusively in Germany and now plays an important part in the film industry; up to 300 features are dubbed in one year in Germany.

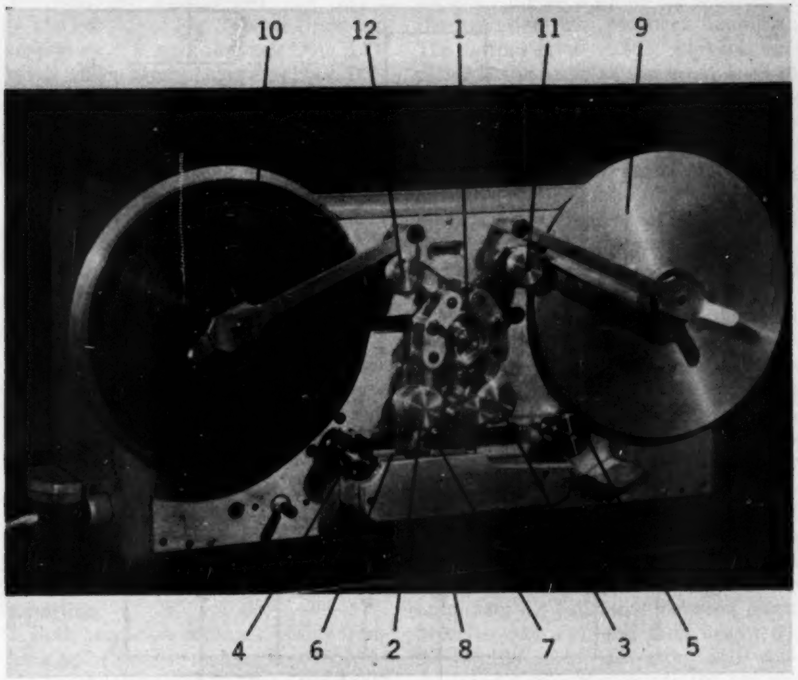


Fig. 1. Magnetic sound recorder.

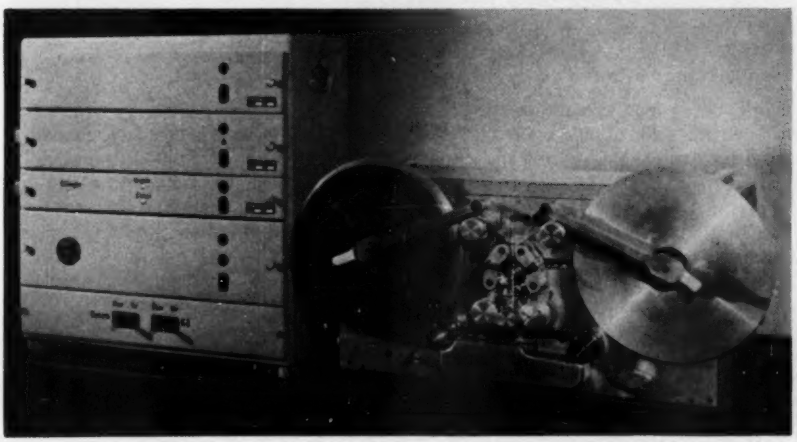


Fig. 2. Assembly of magnetic sound recording equipment.

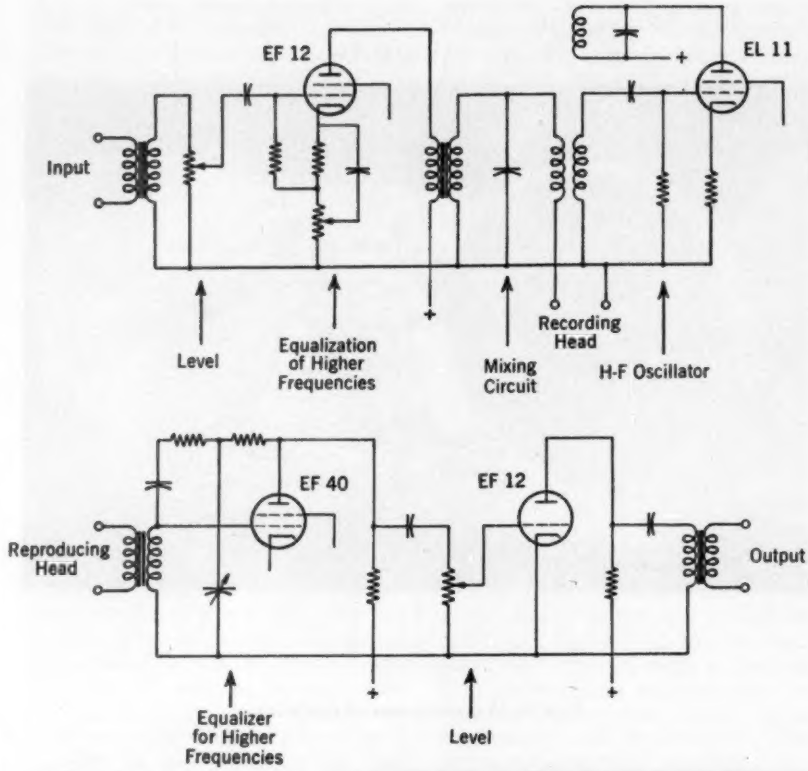


Fig. 3. Schemes of: (above) the recorder; (below) playback amplifier.

recorder does not contain an erasing head, entire rolls of magnetic film are erased for the whole studio in the sound department.

For recording and reproducing, the main motor drives the take-up spindle (9) and for rewinding, the supply spindle (10). In rewinding, the film is released from the sprocket wheel. Rewinding speed is three times greater than normal speed and should rewinding of the whole reel be desired, this can be done directly from the take-up spindle (9) over the guide rollers (11 and 12) to the supply spindle, at a speed five times greater than normal. Connected to the roller (11) is a footage indicator, by which it is possible to rewind exactly to the start of the required take. It is automatically arranged so that no recording can be done while rewinding; the recorder cannot be operated unless all the rollers are in their proper positions, and rewinding cannot be done if the film is still in the sprocket.

With this construction the recording takes place beside the sound drum, i.e., beside the spot which has the highest uniformity of speed. This results in low-amplitude modulation, while flutter is brought down to 0.06%, which is considered a satisfactory amount.

The Amplifier Equipment

The left side of Fig. 2 shows (from top to bottom): a recording amplifier, 100-mv input; a reproducing amplifier, 100-mv output; an indicator amplifier (Tonmesser); a monitor power amplifier, 5- or 20-w; and a switchboard with the "direct-playback" switch. Distortion factor of the three amplifiers is below 1%.

The recording amplifier contains a volume control and a variable compensation for losses of the high-frequency response due to the sensitivity of the magnetic film, reaching a maximum of 15 db. The reproducing amplifier compensates for the remainder of the losses of the high-frequency response of the magnetic film and the wear and tear of the reproducing head up to a maximum of 12 db. Apart from this it has the rising frequency characteristic in the lower frequencies of 6 db per octave. As is the case in German broadcasting, the lower frequencies are not raised when recording.

Both amplifiers contain a strong feedback and equalizer making it possible to obtain stability and freedom from distortion. Figure 3 shows the schemes of the recorder and playback amplifier. The output level of the playback amplifier is the same as the input level of the recorder amplifier, and when transferring from one magnetic film to another they can easily be connected. In this studio there are also recording channels for magnetic film with a frequency range which permits all parts of the recording and playback equipment, including loudspeaker, to be adjusted to give a flat response up to 15 kc.

When mixing on photographic film the frequency range is cut off at about 7 to 8 kc, due to the high-frequency distortions of the variable-area recording which is in general use in Germany. The mechanical construction of the amplifiers is based on the latest amplifier technique in Germany, consideration being given to standards and the use of high-quality parts. The lids of these amplifiers can be taken off from the front as shown in Fig. 4. The length of the amplifiers (i.e., distance between screw holes) is 550 mm, and their height 60, 95 or 130 mm. Resistors and condensers are mounted inside the chassis

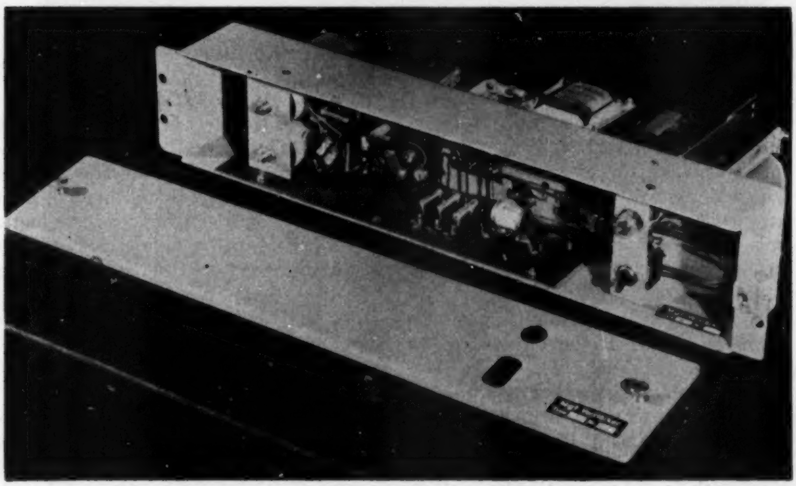


Fig. 4. Recording amplifier, with lid removed.

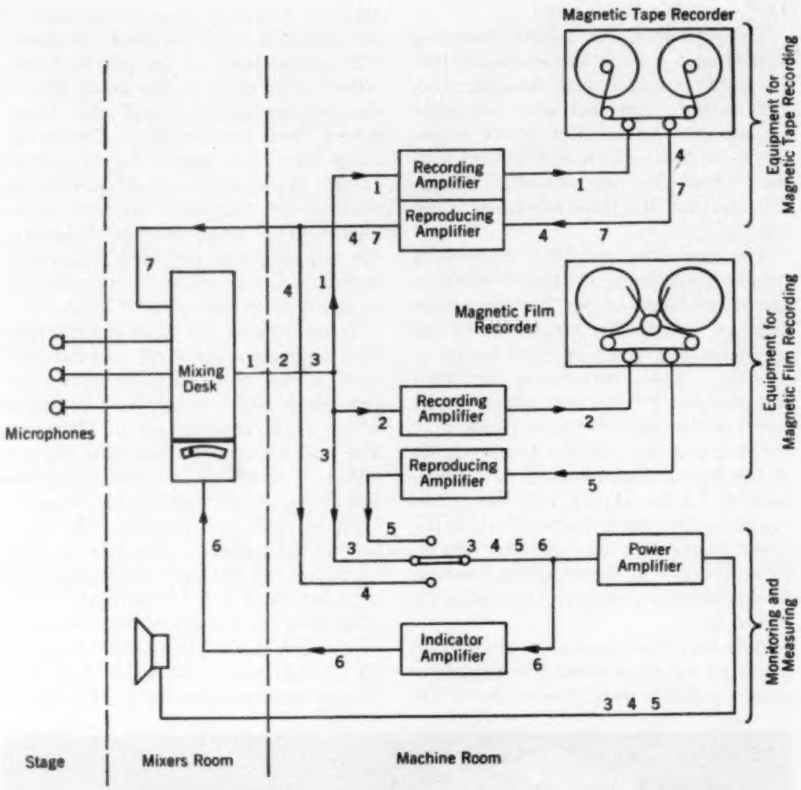


Fig. 5. Block diagram of sound recording equipment.

whereas the valves, chokes and transformers are mounted on the top. This makes it easy to get at the amplifier connections thus enabling one to measure while the amplifier is energized; it is also easy to exchange the amplifier for another one.

A layout of the sound recording system for magnetic tape and film in this studio is shown in the block diagram of Fig. 5. Microphones, of the condenser type, and the mixing table of existing photographic sound channels had to be retained. Recording can be done from the mixer on: (a) magnetic tape, path 1; (b) magnetic film, path 2; also (c) tape and magnetic film, paths 1 and 2; (d) transferring sound from tape to magnetic film, path 7 (2). When recording or re-recording, the signal can be heard: (e) directly (at rehearsals), path 3; or by (f) monitoring of magnetic tape, path 4, or by monitoring of magnetic film, path 5 (while recording). In the above examples the volume indicator in the mixer panel is always in action, path 6.

Visible Registration

Before the magnetic films are forwarded for editing and reviewing, the envelope of the sound waves is visibly recorded on a special apparatus (Fig. 6). This apparatus consists of a driving

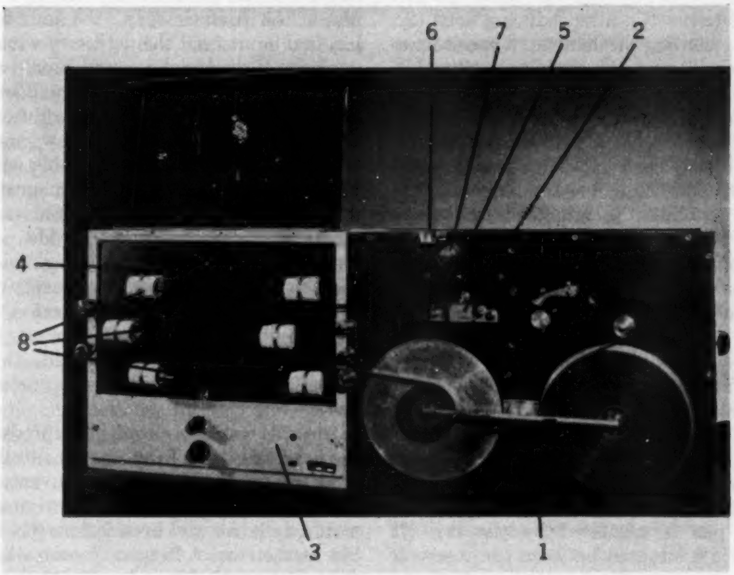


Fig. 6. Machine for adding visible signal.

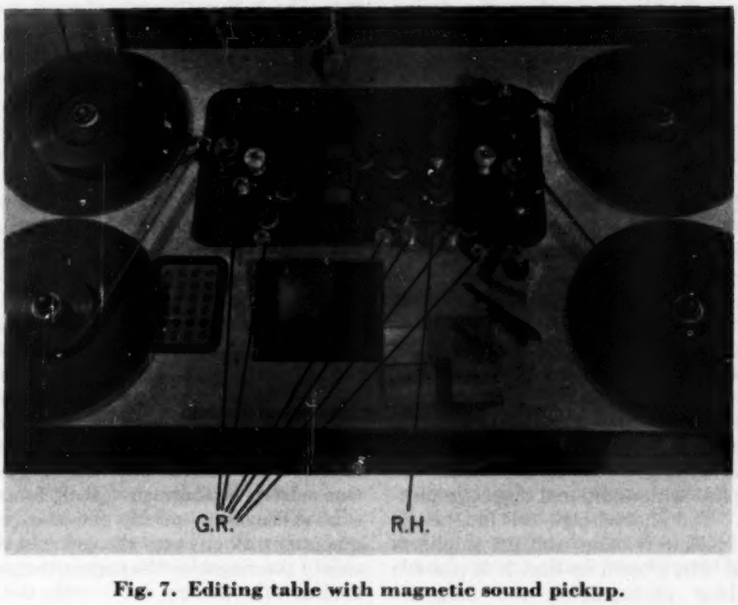


Fig. 7. Editing table with magnetic sound pickup.

mechanism (1), a reproducing head (2), the recording mechanism, a special amplifier (3) and the drying chamber (4). The speed with which the film is transported is about one-third the normal film speed. On a certain spot the reproducing head picks up the recorded signal and the induced voltage is fed to the amplifier, is amplified and rectified so that the output voltage of the amplifier shows only the envelope of the signal voltage. A peculiarity is that low signals produce a relatively higher output than loud ones. This permits even low signals to be easily recognized.

The output voltage of the amplifier is fed to a dynamic system, the moving coil of which carries a special pen. This pen is normally supplied with black drawing ink through a rubber tube (5) from a reservoir (6). The ink supply for the pen is regulated by the tap (7) which is situated between the reservoir and the pen. The pen can easily be removed for cleaning purposes. Between the writing point and the take-up spindle the film passes through a drying chamber which consists of heating tubes (8).

Film Editing

Only German editing tables (cutting desks) of the horizontal type are employed here. These contain four drums for picture and sound, normal and fast, forward and backward running, and continuous (nonintermittent) picture projection. There is a scale which shows the number of frames out of synchronism between picture and sound. Small projection is on frosted glass and large projection is on a picture screen. The American type "Moviola" editing machines are not common here and are considered uncomfortable and noisy.

All editing tables in the studio are supplied with additional magnetic pickups. The photoelectric cell for the optical pickup remains, and the amplifiers have been altered so that it is possible to hear photographic and magnetic film at the same time, i.e., the amplifier has two inputs and the necessary equalizing for the magnetic sound reproduction. In order to drive split magnetic film, the only mechanical additions necessary on this table are a few guide rollers. Figure 7 shows this table with the additions necessary for magnetic film; R.H. is the magnetic reproducing head, G.R., the additional guide rollers. Attached to the extreme right side of a few of these tables is a separate reproducing head which is connected to the amplifier; the magnetic film can be drawn by hand over this head, thus giving an additional aid for the cutting process.

At a few tables a "rotating reproducing head" has been fixed experimentally. This was originally a military invention which made it possible to hear single words, syllables and even letters slowly, but at the correct frequency even when the tape is stationary. Some cutters are so experienced that they are able to cut a film in the middle of a word without the aid of the above-mentioned two sorts of equipment.

Further aids to the cutter are the so-called click-pencil and the hand eraser. The click-pencil is a colored grease pencil containing an iron oxide powder for markings on the magnetic film, Such a pencil marking on the film produces a click sound when passing over the reproducing head and enables the cutter to make markings which can easily be wiped off when no longer needed. The hand eraser is an ordinary magnetic erasing head built into a "handle-shaped" fitting. This head is fed with strong high-frequency current which permits the erasure of unwanted noises, bloops, etc., on the magnetic film, and can, with practice, be used to swell or to restrict the sound volume of music, etc. Our cutters, in contrast to their American colleagues, quickly become acquainted with any new changes. In the case of the magnetic film each cutter was anxious to be the first one to make use of

it with the result that all the cutters are now used to this method and enjoy working with it. Other advantages for the cutter, apart from noninflammability and better sound quality, are that joints and scratches cannot be heard, and dust and fingerprints do not affect the film. All tools used by the cutters and their assistants must be demagnetized regularly before commencement of work. The same applies to the metal parts of the cutting desk, recorders, reproducers and projectors. This has become a general routine in the studio.

One copy on magnetic film transferred from 6.5-mm tape is sufficient for some productions, for instance, "dubbing" foreign pictures. Even though the film has been cut for several weeks it shows no signs of deterioration when brought to the final re-recording. A sound track can always be copied from the 6.5-mm original tape in case the magnetic film should be damaged. For security purposes some other productions prefer to take two magnetic film copies from the 6.5-mm tape. The first of these copies, which is used as a working copy, is sent to the editing room for cutting and review purposes. When the cutting of this copy is completed the second copy is cut exactly like the first one and is ready for re-recording use. This cutting is made easier by the use of visible "envelope" recording and a careful marking of the surface of the material with white ink, as is done with photographic film.

Magnetic film stock, which has already been in use, can, in general, be used again, but only as leader. This material is used by a few small productions for recording a second film on it, thus reducing the material cost by about 50%. One drawback, however, is that only the same type of material should be joined together; oblique joints have proved to be the best and it is possible to record sound signals over such a joint without any noticeable effect. When reusing magnetic film the visible record can be washed off or the new envelope record can be made with an ink of a different color.

Reviewing

Two types of projector are in use in this studio. A pickup for 17.5-mm magnetic film has been added to some of the reproducers, the pickup heads of which are mounted beside the sound drum. In other review rooms there are reproducers of the re-recorder type described below which can be interlocked with the projectors and driven synchronously. In both cases monitoring amplifiers of the previously described standard type are employed and are fed into the second input ("microphone") of the motion picture amplifier. Apart from reproduction of dailies, whole pictures with sound re-recorded on magnetic film can be reproduced by these machines without a pause (stop), thus resulting in better sound quality even when reproduced over the already existing reproducing channel.

Re-recording Equipment

No other device for magnetic film reproducing has been added to the already existing optical sound reproducers, but parallel to these, a series of eight magnetic sound reproducers were installed.

Each of these reproducers, of which Fig. 8 shows three, consists of a motor with gear, a "sprocketless pulling drive" with the sound drum and a winding-off and winding-on mechanism. The motors are fed by a d-c interlock power unit. The film-driving mechanism as shown in Fig. 9 was reconstructed from a similar optical apparatus. A high degree of uniformity of motion is guaranteed by a big flywheel on the shaft of the sound drum (1) and a sprung loop-catcher with a graphite pump (2). Here can also be found the playback head (3) mounted directly behind the sound drum. Each reproducer has a

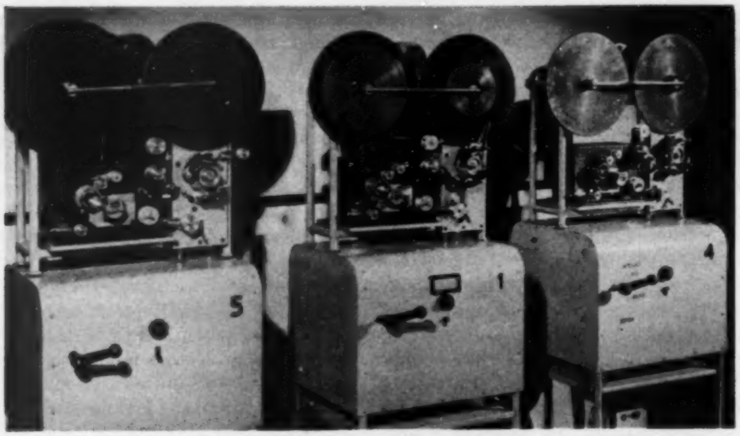


Fig. 8. A series of magnetic sound reproducers.

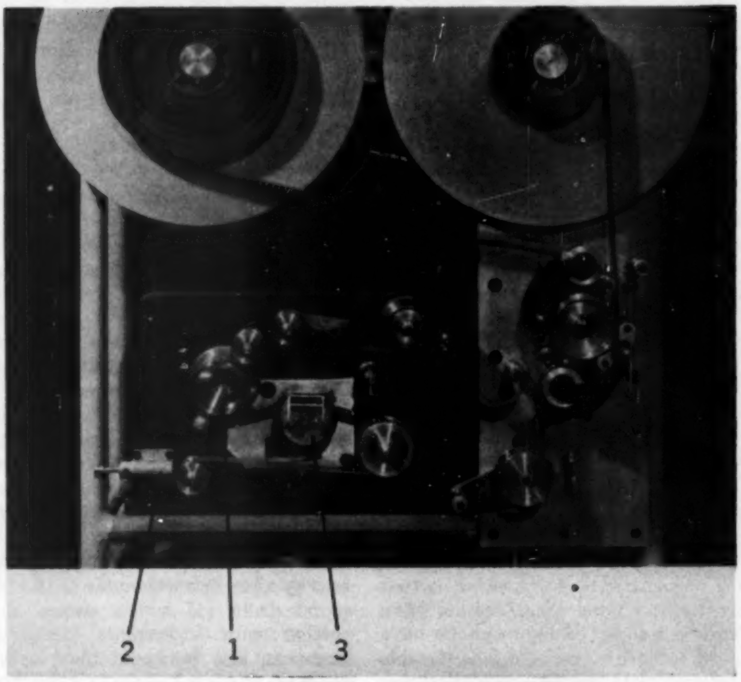


Fig. 9. A detail of magnetic sound reproducer.

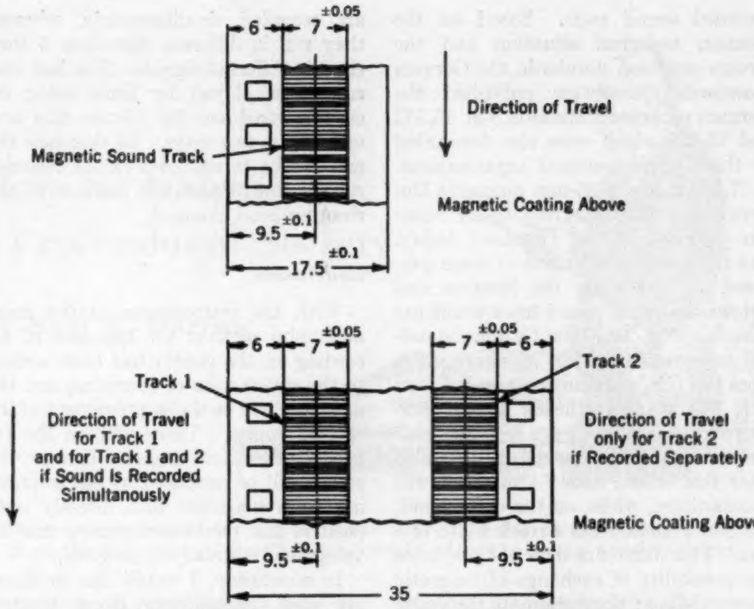


Fig. 10. Situation of sound track, from proposed standard.

standard reproducing amplifier with the magnetic sound equalizer.

Re-recording is done on magnetic film. After completion of the re-recording the reels are checked carefully for sound qualities, and the o.k. reels, one after the other, are re-recorded onto negative film. This method has the greatest saving advantage even though the process takes longer.

Magnetic Film Stock

The following four firms are the magnetic film suppliers in Germany:

1. Agfa, Leverkusen (a part of Bayer works), British Zone,
2. Badische Anilin und Sodafabrik, Ludwigshafen, French Zone,
3. Anorgana, Gendorf/Bayern, U.S. Zone, and
4. Agfa, Wolfen, Soviet Zone.

All four firms formerly belonged to the I.G. Farben and have for years also produced 6.5-mm tape. No magnetic film material whatsoever is imported. The two Agfa firms use an acetate base for the magnetic film, whereas the Badische Anilin und Sodafabrik use a base of polyvinyl chloride. The Anorgana does not produce a double-layer film, i.e., with oxide coating, but a homogeneous material containing powdered oxide. The thickness of all materials is between 135–150μ.

Standardization

Because this studio was the first to build magnetic film equipment in Germany, we were obliged, right from the start of the new technique, to fix temporary standards so that corresponding developments in the different studios and apparatus-building firms could commence from these fixed standards; of course, already existing and proposed foreign standards, British and American, were considered, in order to guarantee later exchange possibilities of magnetic

recorded sound reels. Based on the German technical situation and the foreign proposed standards, the German Standards Committee published the German proposed standards Nos. 15,552 and 15,553 which were also forwarded to the foreign standard organizations. A 17.5-mm and a 35-mm magnetic film were standardized but only the 17.5-mm film is employed in Germany today. The most important parts of these proposed standards are the location and dimensions of the sound track which are shown in Fig. 10. The German standard unavoidably differs in some points from the U.S. standard because:

1. The magnetic heads usually employed in Germany have a width of 7 mm and as there was no necessity to alter this width, this 7-mm track was standardized, while, on the other hand, the U.S. standard has a track width of 5 mm. This difference does not prejudice the possibility of exchange of magnetic recorded films; the distance of the sound track from the edge of the film is 6 mm in both standards.

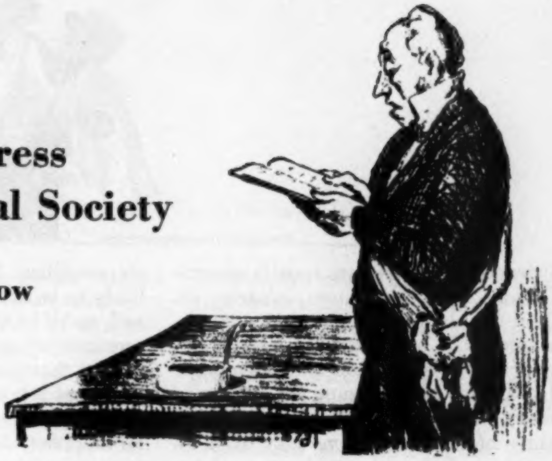
2. On the 35-mm film only two tracks are standardized. Both tracks run in the same direction if they contain the same signal or stereo sound, i.e., if they are recorded simultaneously, whereas they run in different directions if they contain different signals. The last case can be employed by firms using recording machines for 35-mm film and utilizing it two ways. In this case the reel can be turned over or the recorder run backward and the position of the recorder head changed.

Conclusion

With the introduction of the magnetic film method the question of recording in the studio has been settled to the satisfaction of everyone, and the next step will be the improvement of the theater copies. There will, in the future, be no sound negative because the copies will be produced by electroprinting from magnetic film directly onto positive film (combined print); this development is already in progress.

In conclusion, I would like to thank my staff, particularly Horst Redlich and the mechanics in the workshop of Mr. Albrecht, for their assistance and cooperation in the various problems in the construction of mechanical devices and in the development of the amplifiers.

How to Address a Professional Society



By Karl K. Darrow

Does everyone head for the corridors when you rise to read your paper? If so, the Secretary of the Physical Society wishes to have a word with you.

Consider an actor in a hit show on Broadway, and contrast him with a physicist addressing the American Physical Society.

The actor has all the advantages. He is speaking lines written for him by a master of the art of commanding the interest of an audience (remember that we are postulating a hit show). He has a gift for acting, and also a long experience in the art; otherwise he would not be in the cast. Even so, he is not allowed to speak his lines in any way that occurs to him. Every phrase, every inflection, every gesture, even the position that he is to take on the stage, has been tested or even prescribed by a professional director, who does not hesitate to give him mandatory instructions, or even to alter the lines if they seem ineffective.

One might assume that assured of such splendid collaboration, the dramatist would write a play two hours long without a break, and the manager would be content to offer the play in a barn with benches for the seats. This is apparently not the view of those who are experienced in such matters. Ample intermissions are provided, and an act which runs for as much as an hour is sufficiently rare to cause the critics to mention it. Usually the theatre has comfortable chairs and is well ventilated or even air-conditioned. All this is provided to induce people to come to a play for the apprehension of which, with rare exceptions, no intellectual effort is demanded.

Now consider the physicist. He has thought out his own lines, and is not always proficient in this not altogether easy art. He has little or no training in the art of elocution, and no director has rehearsed him. His subject requires a considerable amount of mental effort on the part of his listeners. The

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Reprinted from *Physics Today* for February 1951 where it was published as "How to Address the American Physical Society," by Karl K. Darrow, for 33 years a physicist on the staff of Bell Telephone Laboratories in New York City, and for the last ten years Secretary of the American Physical Society at Columbia University.

listeners themselves are usually uncomfortable and sometimes acutely so. This may be because the chairs are uncomfortable, or because the room is hot and stuffy, or because the programme has already been running for an hour or more without a break; or two or all three of these conditions may exist together. Laurence Olivier or Helen Hayes might well quail at the prospect of having to sway an audience under such conditions. Under these highly unfavorable circumstances, does the physicist strive to put on a reasonable facsimile of Olivier or Hayes? It may be conjectured that frequently he does not, because of the popularity of the saying than when a meeting of the American Physical Society is going on, the members are in the corridors or on the lawn instead of listening to the speakers. People with tickets to *South Pacific* are not standing around in Forty-fourth street when the curtain is up.

Can anything be done to amend this situation? Very little, I am afraid, but the following suggestions point in the right direction.

1. *Speak loudly enough to be heard in the remotest part of the room.* Some people sincerely believe that their voices are too weak to achieve this. No doubt this is sometimes the case, but I venture to believe that most of them are wrong. In my youth I was constantly reproached for speaking too faintly, and I thought that I could not help it; experience proved me wrong. I do not think that I could manage a speech in the Metropolitan Opera House without an amplifier, but a physicist is not likely to be asked to speak in so large a hall, and if he were he could count on the presence of an amplifier. In a hall seating three hundred persons or fewer, the amplifier ought to be unnecessary except in pathological cases. If there is an amplifier, do not expect it to transform a conversational tone into a loud one. It is better to go to the opposite extreme, and pretend to yourself that the microphone is not there, even though you are speaking directly into it.

The trick recommended by those who instruct speakers is to look at and speak to the people in the rear row. This is often made difficult by the fact that some of the prominent people in the audience are sitting in the front rows; this is particularly common in University colloquia. If this situation exists, ignore it. If Fermi is sitting in the front row and Joe Doakes in the rear row, speak to Joe Doakes, Fermi will hear you.

2. *Write out your speech in advance, and commit it to memory.* I have heard only one objection (from the viewpoint of the audience) raised against this procedure, and it seems to me groundless. It has been contended that a written speech is dull and lifeless; the implication is that an unwritten speech glitters with sparkling impromptus. But the presence of a manuscript need not prevent the speaker from substituting a sparkling impromptu for something that he has written; and if the impromptu fails to occur to him, the manuscript is there to carry him along. Of course, it is

". . . in the corridors . . ."

possible to memorize a speech without writing it out; this is recommended to those who hate to write. It is a fact that a good speech is likely to be looser in texture than a good article. No difficulty will arise from this cause if the speaker remembers that it is a speech that he is writing.

There are some who think that it is better to hear an unprepared physicist groping for what he wants to say than a prepared physicist saying what he wants to say. It would be fascinating to see this theory given a trial by the Sadler's Wells Ballet, but nobody ever will. For an advanced student of the dance it may be instructive to see a dancer fall on her face, pick herself up, and resume her part in the ballet; but for practically everyone else it is acutely embarrassing.

3. *If you cannot memorize your manuscript, read it aloud.* This bit of advice will probably be resented, for we have all suffered from dreary speeches poorly read. There is, however, no compelling reason why a manuscript should be poorly read. Lady Macbeth has to read a letter aloud in an early scene of the play; it is one of the high points of the drama. More than thirty years ago Ethel Barrymore read a letter aloud in such a way that it is still remembered by elderly playgoers, though the play itself is forgotten. The trouble is largely that most readers glue their eyes to the manuscript for seven-eighths of the time, lifting their eyes from time to time to steal a glance at the audience as though to make sure that it is still there. Reverse the ratio. It is easy to keep your eyes on the audience during seven-eighths of the time and look at the manuscript during the other eighth. For a manuscript which you have composed yourself, it should be extremely easy. Try it and see.

4. *Situate your topic in the general framework of physics at the beginning, and summarize your conclusions at the end.* Even in a ten-minute paper, a minute at the beginning and a minute at the end are not too much to reserve for these purposes. Do not fear to repeat your main points. I shall have more to say on repetition near the end.

5. *Time yourself.* The members of the American Physical Society are now pretty well trained in the art of giving ten-minute papers, but longer ones are still apt to overrun. This is particularly serious when the closing bell rings when the speaker still has five minutes to go, and these five minutes comprise the conclusions which are the incentive for the paper. The speaker naturally does not want to omit the climax of his speech, and the chairman is seldom ruthless enough to insist.

This is when having a manuscript is particularly useful. Timing-marks can be inserted at the end of each page or along the margin, and the speaker (who should constantly be looking at his watch) will then know when he is running behind and will be able to catch up by leaving out relatively dispensable passages. One hundred and thirty words a minute, or say two-and-a-half minutes for a double-spaced typewritten page, is

fast enough. In the timing, allow for twenty seconds or thereabouts of silence just after you make each of your difficult points. These gaps will give the audience a chance to think about what you have said; there are no laws requiring a speaker to be talking *all* of the time at his disposal. The difficulty in timing is greatest when the paper involves blackboard work or slides. Rehearsal is necessary in such cases, and is worth the effort.

6. *Aim your discourse toward the average of the audience, not toward the topmost specialists.* Too many young theoretical physicists speak as though they were instructing Oppenheimer; too many bandspectroscopists, as if they were addressing Mulliken; too many solid-state physicists, as though the audience consisted of Seitz—and so it goes. This is not quite so flagrant a fault as it was in the days before the meetings of the Society splintered into simultaneous sessions, each attracting its own coterie of specialists; but it is still an error, and anyone who avoids it is doing his bit toward the all-important end of keeping physics from breaking up into a horde of narrow specialties.

There is one specious argument for the procedure which I am deprecating here. The young man may think that the topmost specialist is also the prime job-giver, and therefore is the man whom it is urgent to impress. But in the first place, it seems plausible to suppose that the topmost specialist forms his opinions of the neophytes from their writings and from personal contacts; and in the second place, the job-giver in the audience may be, say, some chairman of a department of physics whose own specialty lies elsewhere, and who is going to assess the young man by his lucidity and not by his profundity. If these entirely reasonable suppositions are correct, the young man is doing himself a disservice by speaking as though he were addressing exclusively those who know more than he.

7. *The problem of the blackboard.* This is one of the toughest of all problems. and here the theatre is of no use. I have never seen a play in which an actor had to write on a blackboard. I think that an actor would write on the blackboard without saying a word, and then turn to the audience and speak. For a physicist the psychological inhibition against doing this is quite invincible, but at least the attempt should occasionally be made. He can at least avoid the tendency to drop the level of the voice while addressing the blackboard. There are, however, two faults at the blackboard which can often be avoided.

One should write his symbols large enough so that they can be read from the back of the room. I hope I never forget the shock which I once experienced when, having finished what I had fondly supposed to be a good lecture, I went to the back of the room and found that nothing I had written could be read beyond the middle rows. Sometimes the speaker finds the blackboard to be much smaller than he had reasonably counted on; in such a case he has to choose between altering his presentation and confining his effectiveness to the people in the nearer rows. Sometimes, of course, either the chalk or the blackboard is impossibly bad; the speaker is then helpless unless he is good enough to revise his plans and do the whole speech without the blackboard. One ought also to write his equations in the order in which he speaks them, instead of putting each in the nearest convenient empty spot and dabbing with the eraser to make more empty spots, so that at the end the board is littered with incoherent symbols. One should know in advance just how the board will look at every moment during the discourse, and at the end of the talk the board should carry all of the principal equations arranged in logical order. I am afraid that this is a counsel of perfection.

8. *The problem of slides.* Most people who show slides at all show too many

and show them too fast. (I suspect that this is often because the speaker has prepared too long a speech and tries to compensate by racing through the slides.) Rare is the slide which can be properly apprehended in less than thirty seconds, though exceptions do occur. It is impossible to assign a rigid maximum to the number of slides which can be shown effectively. I suggest seven for a ten-minute paper, but I make exception for the cases in which the argument is shown on slides instead of on the blackboard. The one advantage of the blackboard over slides is that the overfast speaker is obliged to slow down as he writes; this advantage can be shared by the slides if the speaker will give them time enough. There is much else excellent advice to be given about slides, but it has all been said by J. R. Van Pelt in the July 1950 issue of *American Scientist*. This should be required reading for all physicists.

9. *The problem of the "jargon."* Some people ascribe the difficulty of understanding science to what they call the "jargon." This seems to imply that scientists use long technical terms out of perversity, when they could just as well use short familiar words. This is absurd. If I am giving a speech on a subject involving entropy or a synchrocyclotron, less than nothing will be gained if I avoid the word *entropy* or the word *synchrocyclotron* by some cumbrous periphrase or by some vivacious popular word which does not mean the same thing. Entropy is entropy and a synchrocyclotron is a synchrocyclotron, and there is no synonym for either. On the other hand there is nothing to prevent me from giving a brief definition of either. It does not have to be a complete definition: I may say that entropy is $\int dQ/T$ between certain limits of integration, or that a synchrocyclotron is a cyclotron in which the frequency is modulated so as to overcome the obstacle arising from the change of the mass of the nuclei with their speed. It may be objected that a person who does not know in advance what these words mean is unable to profit by the discourse. This view fails to take account of the fallibility of human memory. The listener may have forgotten what the words mean; he may even be able to recover the meanings during a few seconds of groping, but during these few seconds the speaker will go so far ahead that the gap cannot be closed. I have often observed that the place at which I lost contact with a speaker was the place at which he used a word which made me stop and ponder. It seems worthwhile to try to avoid such dangers.

There is a sense in which physics is afflicted by what may be called jargons, though I should prefer to call them private languages. This is a phenomenon of recent years. Formerly physicists were few and far between, and one who did not make himself understood to his fellow-physicists a thousand miles away did not make himself understood to anybody. Nowadays many physicists do team work in large groups. In every such group a private language arises, characterized first of all by omissions. Relevant facts and even essential steps in an argument can safely be omitted within the group, because everybody knows them. In addition, the group invents all sorts of abbreviations, nicknames, and pet names for such things as parts of an apparatus, cosmic-ray tracks of various aspects, irregularities in crystal lattices, phenomena of hole-conduction, and even basic concepts of physics. No dictionary contains these terms; they travel by word of mouth, and often they do not travel fast enough. When they are spilled out before a meeting of the Society, disaster may ensue if they are not defined. Facility of travel and interchange of personnel are doing much to retard the development of a Berkeley language, an Oak Ridge language, a Murray Hill language and the like; but the danger is always with us.

10. *Style.* The concept of style being vague and the teaching of style lying in the province of another profession, I confine myself to two remarks.

Textbooks of style advise the writer, and therefore inferentially the speaker, to strive for a proper proportioning of long words with short, and (what often comes to the same thing) of words of Greek, Latin, or French origin with words of Saxon origin. Now, a scientific article is perforce overloaded with words which are both long and of Greek or Latin origin. This suggests that whenever the speaker has an option, he should choose the short word over the long and the Saxon word over the Greco-Latin. If a sentence contains such words as *ferromagnetism* or *quantization* or *electrodynamics*—not to speak of the atrocious *phenomenological*—it is really amazing how much the sentence will gain in grace and fluency if all the other words are colloquial and short. This policy also tends to bring out the necessary long word in bold relief.

It is said that the style of our forerunners was largely formed by the King James Bible, and that the style of our contemporaries is influenced by the *New Yorker*. Neither of these publications can have much influence on those who do not read them. The suggestion is that physicists should not confine their reading to their professional literature. Read novels; read poetry; read essays; read history as written by notable writers; read Winston Churchill and read Rebecca West—or if you simply will not go beyond the writings of scientists, read the Braggs and Eddington and Jeans and Bertrand Russell. Failure to observe this precept is partly accountable for the fact that it is seldom possible to tell from the style of an article in the *Physical Review* who wrote the article, and for the further fact that scientists who try to write something for the general public so often do it badly.

11. *A suggested experiment.* I have proposed, *inter alia*, that a speaker should speak slowly, show his slides slowly, define his private-language terms and repeat his main points. To anyone who deprecates this advice I suggest the following experiment.

Choose an article in *Physical Review;* let it be in your own field if you will, lest the result of the experiment be too frightful. Sit down in an uncomfortable chair, and read the article—but read it according to the following prescriptions. Read straight through from beginning to end at the rate of 160 to 180 words per minute. Never stop to think over anything, not even for five seconds. Never turn back, not even to refresh your memory as to the meaning of a symbol or the form of an equation. Never look at an illustration until you get to the place where it is mentioned in the context; and when you get to that place, look at the illustration for ten or fifteen seconds and never look at it again. If this is not the way that your listeners will apprehend you when you give a paper, you are an outstanding speaker.

Illustrations by H. Daumier, courtesy New York Public Library

ABSTRACT

High-Diffusion Screens for Process Projection

By Hugh McG. Ross

I. Requirements of Translucent Screens

One essential difference between front and back projection lies in the manner in which light leaves the screen and enters the lens of the camera or the eye, and to consider this we must imagine the film or slide removed from the projector and the blank screen illuminated. The distribution or unevenness of the brightness of the screen which is then seen will still be present when the picture is superimposed upon it, In back projection very little light is reflected; most of it passes through the screen and is scattered to some extent. The effect is shown diagrammatically in Fig. 1. The angle between the incident ray and the screen makes little difference in the shape of the curves. However, when the screen is photographed or observed from the camera position, the intensity of the light coming from the center of the screen is greater than the intensities from the edge and corners. This explains the existence of the well-known "hot-spot" characteristic of back projection.

The magnitude of the nonuniformity of the screen brightness depends upon the angle through which the light must be diffused in passing from the projected light beam to fall on the camera lens. This angle is the sum of the angles from the camera and projector lenses. The values of such angles at the corners of the screen for various projector and camera lens focal lengths is shown in Table I. For the great majority of process shots the total angles

Abstract by F. B. Berger of a paper by Hugh McG. Ross, published in *J. Brit. Kinemat. Soc.*, vol. 16, no. 6, pp. 189–199, June 1950.

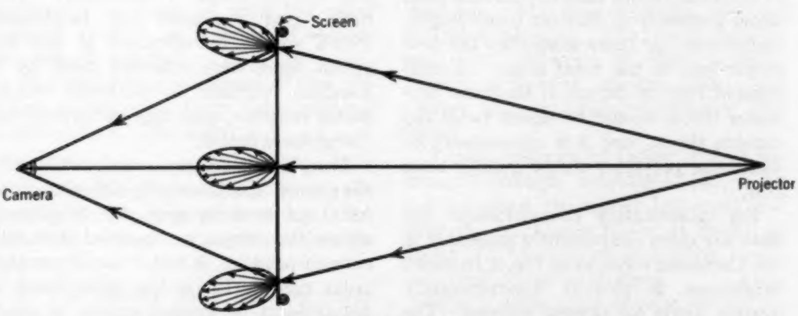

Fig. 1. The way in which light is scattered on passing through a diffusing screen.

The length of each arrow represents the intensity of the light in the direction of the arrow, and the polar curve joins the tips of the arrows.

Table I. Camera and Projector Lens Angles

35-Mm Camera Lenses								
Focal length, mm...	25	28	35	40	50	75	100	
Corner angle, deg..	28.6	25.9	21.2	18.8	15.2	10.3	7.8	
35-Mm Process Projector								
Focal length, in.....	2	3	4	5	6	7	8	9.25
Corner angle, deg...	16.4	11.1	8.4	6.7	5.6	4.8	4.2	3.6
Still Projector, 3 × 2.2 in.								
Focal length, in.....	6.4	8	10	12.5	14	16	18	22
Corner angle, deg...	16.2	13.1	10.5	8.5	7.6	6.6	5.9	4.8

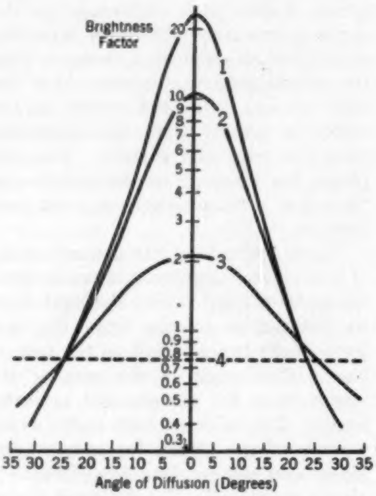

Fig. 2. A preferred way of drawing the polar diagram.

Curve 1: measured at corner of typical graded screen in normal use.
Curve 2: measured at center of the same screen.
Curve 3: new high-diffusion screen.
Curve 4: nominal performance of good front-projection screen for comparison.

range from 15° to 30°. An examination of the data shows that the camera lens, being generally of shorter focal length, contributes far more than does the projector lens to the total angle. A convenient rule of thumb is that the projector throw should be about twice the camera throw, and it is unnecessary to make the projector throw greater than this.

For quantitative considerations the data are more conveniently presently in the Cartesian form, as in Fig. 2, in which brightness is plotted logarithmically against angle for several screens. The measurements were made by projecting a steady light on the screen and observing the brightness of several test areas of the screen from different angles, using either a Morgan Reflectometer or the S.E.I. Visual Photometer. The units used represent the brightness which would be obtained if the incident light were reflected back by a Lambert surface, a perfectly white matte reflector, and may be termed the "brightness factor."

If a uniform screen is used, made with the same thickness of diffusing material all over its area, the brightness across the screen, as observed from the camera position, is rather similar to this polar curve. If, on the other hand, a nonuniform or graded screen is used, made with additional diffusing material near its center, the complete brightness distribution curve cannot be assessed so easily. For example, the

two upper curves of Fig. 2 are for the best type of graded screen hitherto available. These curves show that if the projector side of the screen is uniformly illuminated, the center is fifteen times brighter than the corners at 25°. The hot-spot produced in such a case may be partly overcome by placing metal discs in the center of the light beam. These discs reduce the intensity of the light falling on the center of the screen, but with skilled use they need not reduce the intensity of light falling on the edges and corners. They have the serious practical disadvantages that it takes considerable time to position them, and the movement of the camera is restricted.

Curve 3 of Fig. 2 illustrates the new high-diffusion screen. The first important point is that the center is only two or three times as bright as the corners. This overcomes the hot-spot effect, and considerable experience with these screens has shown that the great majority of back-projection shots, including Technicolor, may be thrown up on the screen without any hot-spot being noticeable. This curve is found to be better than an even more uniform one.

The second important point is that the brightness of the corners of the picture is as great as with the older screens, so that no increase of camera exposure is required.

The new screen possesses several distinct advantages from the practical point of view. These are:

1. The camera may be moved parallel to the screen surface without having the average screen brightness or light distribution change to any objectionable degree.

2. The camera may also be freely moved in a direction normal to the screen surface.

3. The freedom in panning and tilting the camera without objectionable changes in average brightness or uniformity is considerably greater with the new screen.

4. The accuracy with which the optical axis of the projector is aligned with the camera axis and with the screen is much less critical than with older screens.

All the effects described are independent of the scale of the setup. Larger pictures require simply greater light output from the projector to maintain the same brightness as for the smaller picture. Even the definition is not affected.

The best method of making light measurements on a diffusing screen is to use a narrow-angle photometer while standing at the camera position, the S.E.I. Visual Photometer having proved particularly suitable.

II. Experimental Study of Screen Properties

A systematic study has been made of diffusing materials for screens with a view toward finding out which qualities are important for the quality of the screen and also which other qualities have no useful effect. Both the diffusing material and supporting material must be colorless and should be unaffected by age, weather conditions or washing. The base material is preferably a plastic. The most suitable are ethyl cellulose or ethyl acetate. Finely powdered optical glass was chosen as a satisfactory diffusing material.

Another important factor is that the straight-through brightness factor be not too great (to reduce hot-spot) and that the brightness factor at angles of about 25° be as much as possible to ensure high corner brightness.

Over a wide range of samples, an increase of diffusion reduces the straight-through brightness factor but makes little difference at 25° or 30°. This effect gives control over hot-spot.

A number of typical brightness vs.

angle curves are presented in the paper. A study of the results shows that the following factors do not affect the optical properties of the screen:

1. It does not matter whether the diffusing particles are on or near the surface or are embedded throughout the base.

2. It makes no difference whether the diffusing material is incorporated in the liquid base plastic and cast, or whether the screen is built up by spraying a mixture of diffusing material and plastic lacquer.

3. The same diffusion is obtained by one high-diffusion screen or two low-diffusion screens placed close together. The latter, of course, may affect resolution in certain cases.

4. Over a considerable range, the size of the diffusing particles makes no difference. It is probable that the optical characteristics are chiefly controlled by the number of particles rather than the total weight. The largest particles should be considerably smaller than the screen thickness and the smallest should be several times the wavelength of light.

5. It is immaterial whether the diffusing particles are of uniform size or mixed.

The most important fact revealed by the investigation is that the shape of the polar diagram may be altered by changing the refractive index of the material used for the diffusing particles, so that by the correct choice the corner brightness is made as high as possible. Almost certainly the important criterion is the difference between the refractive indexes of the plastic base and the diffusing particles, but the indexes for all suitable plastics are similar so that the index for the particles is the most relevant. Experimentally, the preferred index is about 1.6 to 1.7, although no theoretical explanation has yet been established as to why this is the case.

III. Method of Manufacture of Screens

The use of powdered glass for high-diffusion screens is covered by British Patent 27,812 (1949). Essentially a method of making the screens consists of spraying a cellulose lacquer onto a false ceiling, powdered glass being mixed with the lacquer for some of the layers.

The ceiling used is constructed of ordinary trowelled plaster on the usual laths, supported from a suitable framework. The spraying is done from below. The plaster is first prepared by spraying it with a suitable gelatin solution. It is followed by applying a layer of ethyl cellulose lacquer with a spray gun. Fabric tapes are then applied to strengthen the edges of the screen. The powdered glass is next sprayed on, this being the most difficult part of the process since uniformity of coverage must be achieved. The powdered glass is mixed into the lacquer for spraying, a true wet spray being obtained. After drying two or three days, the screen is stripped off the gelatin-treated plaster. Eyelets are put into the edge-tapes, and after the screen has been laced into a frame it is ready for use.

The Scientific Basis for Establishing Brightness of Motion Picture Screens

A Discussion of Screen Brightness

By Frederick J. Kolb, Jr.

Discussion Participants

W. W. Lozier, Chairman of the Screen Brightness Committee, National Carbon Co. Division of U. C. & C. Corp.
G. A. Chambers, Eastman Kodak Co. Motion Picture Film Dept.
R. M. Evans, Eastman Kodak Co. Color Control Dept.
F. J. Kolb, Jr., Eastman Kodak Co. Dept. of Manufacturing Experiments
D. F. Lyman, Eastman Kodak Co. Camera Works
S. M. Newhall, Eastman Kodak Co. Color Control Dept.
Brian O'Brien, University of Rochester Institute of Optics
Otto Sandvik, Eastman Kodak Co. Research Laboratory
S. D. S. Spragg, University of Rochester Dept. of Psychology
K. F. Weaver, Eastman Kodak Co. Research Laboratory
D. Wood, Eastman Kodak Co. Camera Works

Last summer, Dr. Lozier, as Chairman of the Screen Brightness Committee, initiated a discussion of the scientific basis for establishing screen-brightness values, in order to secure technical advice for the Committee. Prof. O'Brien suggested that a conference be held at Rochester, N.Y., and as a matter of expediency only men available in Rochester were asked to attend. These were men actively engaged in the fields of projection optics and psychology. This report covers the discussion held at Rochester on June 19, 1950.

Purpose of the Discussion

Dr. Lozier reviewed the background for this discussion by noting that a "temporary standard" for the brightness of motion picture screens was adopted by the Society in 1938,[1] after the available data had been summarized in the 1935–36 symposium of the Screen Brightness Committee.[11] Slight modification was made in 1944,[2] but actually the interval from 1936 to the present has been characterized by the accumulation of considerable fundamental information without the opportunity for consolidating the data, or for the Screen Brightness Committee to consider modification of the temporary standard. This meeting of specialists active in fields relating to the screen brightness of projected pictures, therefore, was called to discuss the experimental and research accomplishments since 1936, to review and redefine the present gaps in our scientific background, and to discuss possible programs for collecting the information that should be available in order to reassess the screen-brightness standard.

INTRODUCTION

The present standard for screen brightness (Z22.39–1944),[2] Dr. Lozier pointed out, specifies "the brightness at the center of a screen for viewing 35-mm motion pictures shall be 10 ft-L (+4 or −1 ft-L) when the projector is running with no film in the gate."

Origin of Standard

In discussing the present standard, Dr. Lozier pointed out the work culminating in the SMPE symposium of 1935–36 which led to the adoption of a screen brightness standard. The Committee report,[11] relying upon the survey of technical knowledge presented in the symposium, discussed, first, the desirable levels of screen illumination, and second, attainable levels. The fundamental data of physiological optics were not directly applicable to the problem at that time, the Committee concluded, because the work had not been complete enough to permit the prediction of response under theater viewing conditions. Instead, consideration was given to the more practical experiments reported by Luckiesh and Moss,[7] Wolfe,[15] and O'Brien and Tuttle.[8] From these observations the Committee concluded that an ideal brightness level probably should be something in the order of 30-ft L, and that a peripheral brightness of the order of 0.05 ft-L would be desirable at this brightness level.

Considering next the properties of release prints, the Committee decided, on the basis of the work reported by Tuttle[14] that very little change in print density can be expected since: (1) Release prints can be made no more transparent because of the limitations of the existing photographic materials; lighter printing would endanger tone reproduction in the highlights. (2) It would not be practical to increase print density since an increase of about 0.15 in density would be necessary to place the highlight density of release prints nearer to the straight-line portion of the characteristic curve for positive film; one might thereby improve tone reproduction, but only at the expense of a necessary increase in illumination approximating 40% to maintain equal apparent brightness. For the slight advantage offered, this shift in print density (probably requiring a reduction in screen size to maintain picture brightness) was judged impractical.

Considering then what screen brightnesses might be possible with existing equipment, the Committee concluded that for a 30-ft screen an attainable brightness of about 7 ft-L would be the maximum. In order to reduce the discrepancy among theaters, and between theaters and review rooms, the Committee decided that a temporary standard on the basis of attainable brightness would have the advantage of stimulating an over-all improvement in picture quality. Therefore, assuming that a 30-ft screen might be the maximum size which the Society should attempt to recognize, the Committee decided that the minimum acceptable screen brightness should be 7 ft-L. In order to choose an upper limit the Committee attempted to determine what range of brightness could be tolerated without an objectionable change in the apparent contrast of the picture. It was considered undesirable to set the upper limit at 30 ft-L, since this would result in an excessive spread in screen brightnesses among the various theaters. On the basis of Blanchard's data[3] relating the Fechner fraction to field brightness, the Committee selected a maximum value of screen brightness such that the predicted apparent change in contrast would be 15% between the average and either extreme (for picture densities corresponding either to the average of the whole frame, or to the area of principal interest).

Summarizing its recommendations, the Committee said, "The value 7 is

based upon the value attainable for a diffusing screen about 30 ft wide with an efficient optical system in good adjustment. The value 14 is the limiting value beyond which print contrast adjusted for the mean level of 10 ft-L will appear too great. The value should be determined at the center of the screen, with a projector running, with no film in the gate." Subsequently, the Screen Brightness Committee suggested a modification in this standard from 7–14 ft-L to 9–14 ft-L in 1941[12]; the revised standard was adopted by the ASA in 1944.[2]

It should be emphasized especially for those not used to motion picture practice that the screen brightness as specified by the standard is markedly reduced when there is film in the projector and a picture on the screen. Assuming Tuttle's data[14] to be approximately correct for the fine-grain print stock now generally used, *actual picture brightnesses* for a "screen brightness" of 10 ft-L would be as shown in Table I.

16-Mm Projection

The problems of screen brightness for both 35-mm and 16-mm are generally similar, and 16-mm practice has tended to follow the 35-mm standard. It is usual, however, to permit a higher variation from the average brightness in 16-mm installations.

Recent Work

Since the 1936 symposium there has been considerable discussion and some additional work pertinent to the setting of a suitable screen-brightness standard. Reeb[9] reported results of an experimental study in Germany, investigating the contrast sensitivity of the eye under conditions similar to those found in viewing motion pictures. The German investigators concluded that maximum contrast sensitivity occurs at about 14 ft-L, that only the central brightness is important in attaining visual effect, that rapid changes in brightness of a scene do not affect sensitivity, and that screen areas of varying sizes do not cause different brightness impressions. From this it was concluded that the optimum brightness level would be 14 ft-L with the improvement being gradual beyond 8 ft-L. The German investigators further proposed that standardization would be incomplete without specification of the permissible drop of brightness with angle of view, since directional screens are becoming important.

A British survey[4] examined visibility of grain, appearance of flicker and glare, and also tabulated specific comments on individual subjects and on the general quality of projection. From these data curves were prepared from which the Committee concluded that screen brightnesses should conform to the following:

Subject	*Min.*	*Max.*
Black-and-White	12 ft-L	24 ft-L
Technicolor	7 ft-L	14 ft-L

Table I

	Print Density			Screen Brightness, ft-L		
	Min.	Mean	Max.	Max.	Mean	Min.
Average of entire frame	0.67	1.15	1.90	2.1	0.71	0.13
"Face" or area of principal interest	0.60	0.99	1.60	2.5	1.0	0.25
Brightest highlight	0.19	0.43	0.90	6.5	3.7	1.3
Deepest shadow	1.87	2.40	3.20	0.13	0.040	0.0063

Highest scene contrast = 2.45 Lowest scene contrast = 1.38

As a summary recommendation, the Committee proposed a minimum screen brightness of 8 ft-L and a maximum of 16 ft-L, and this has been adopted as British Standard 1404.[4]

Further discussions[5,6,10,13] have been published but it does not seem that they offer any additional basic data suitable for the further analysis of this particular problem. In many cases, however, they provide excellent summaries of the data available and of the practical application of the data, and of standards and recommendations.

Temporary Nature of Standard

In the report of the Projection Screen Brightness Committee presented at the 1936 Spring Meeting it was emphasized that their recommendation was for a tentative standard, to be modified as soon as practical: "It appears to the Committee in view of the arguments that have been presented, that the industry might stand to benefit by the adoption of a temporary screen-brightness standard. Logical limits for such a standard would appear to be 7 ft-L for the low value and 14 for the high value." In its discussion, the Committee concluded that on the other hand an ideal standard "should be something of the order of 30 ft-L and that a peripheral brightness of the order of 0.05 ft-L is desirable at this brightness level. If such a brightness were obtainable logical brightness limits would be 20 ft-L minimum and 45 ft-L maximal."

Having thus proposed a temporary standard—pending the accumulation of more satisfactory data, and pending improvements in the mechanics of projection that might permit higher brightnesses—the Committee listed some of the questions which should be answered in order that the temporary standard might be replaced by an operating standard closer to the ideal range of screen brightness. These questions promulgated in 1936 are as follows:

1. What correlation is there between best print contrast and screen brightness?
2. What effect does the brightness standard have upon the standard of release print quality? Shall release prints of different contrasts be made available to theaters operating at different screen-brightness levels? (Any work done on the standard release print must, for obvious reasons, consider the screen-brightness standard if it is adopted.)
3. Is highlight density, average density, shadow density, density of the area of principal interest, or a combination of these factors, the thing that determines preferred brightness?
4. What possibilities are there for improvement in projection optics, pull-down efficiency, and source brilliance?
5. What is the effect of color of the light source, color of the screen, and color of the print upon the desired brightness?
6. What proportion of moving picture goers see pictures on screen greater than 20 ft, 25 ft, 30 ft? Statistical data on theater sizes, screen sizes, projection equipment and attendance figures are needed by the Committee. A complete paper of this kind would be valuable also in connection with other problems confronting the Society.
7. What factors determine screen width? Would it not be better, for instance, to use a 25-ft screen at 9 ft-L than a 30-ft screen at 7 ft-L? The data of visual acuity tell us that the picture detail visible at great viewing distances should not suffer.
8. What are the possibilities for the development of simple, rugged, and inexpensive brightness-measuring instruments? Cannot a satisfactory simple brightness tester be developed with two fields, one at the higher and one at the lower brightness limit? Could not such an instrument be used easily by the theater projectionist to determine whether he is operating within the recommended brightness range?
9. What is the effect of auditorium illumination upon the required brightness level?
10. What is the effect of the visual angle or the screen size upon this value?
11. What tolerance in nonuniformity of screen brightness from center to edge should be established?

In order to provide a basis for reappraisal of the screen-brightness problem, Dr. Lozier, as Chairman of the Committee, had initiated the conference on June 19, 1950, to discuss what new knowledge was available for supplementing the 1936 summary.

None at the discussion could recall that any work specifically pertinent to the determination of a standard of screen brightness or to the conditions of theater viewing had been accomplished in the interval since 1936. Prof. O'Brien reported that the visual work since that time has been so fundamental in nature or directed to such different ends that its interpretation for the setting of theater viewing conditions might be extremely difficult. The conference thought that the list of questions proposed by the Committee in 1936 was as adequate now as it had been at that time, that little progress has been made toward a direct answer to any of the questions, and that any such answer would result only from studies purposely designed to investigate the desirable brightness of projected pictures.

It was the consensus of the conference that a great deal of work could be done toward determining optimum conditions of theater viewing and that it would be worth while for the Screen Brightness Committee to sponsor such a research program. It was also felt that it should not be too difficult to outline experiments and to formulate a program which would take sufficient account of the difficulties involved to make a real contribution, and to be free of many of the criticisms leveled at early work on screen brightness.

Conditions of Experimentation

The conference agreed that any work pertinent to the determination of optimum theater viewing conditions must simulate very closely the actual theater viewing. Prof. O'Brien and Mr. Evans warned particularly against inferring from the measurement of fundamental visual functions the result under theater viewing conditions. The knowledge of vision and the contribution of the visual functions to the total task of viewing are insufficiently understood.

Scope of Research

In suggesting and sponsoring research on theater viewing the Screen Brightness Committee will be asked to indicate what scope of variables should be included. In the conference discussion, it seemed obvious that the viewing conditions must include the full range of present indoor and outdoor theaters when projecting motion pictures. It is probable that it should include also the range of projected theater television.

Furthermore, research sponsored by the Screen Brightness Committee should aim to determine optimum viewing conditions regardless of their practicability. The research moreover should determine what compromises with this optimum can be made with the least sacrifice of picture quality. The program should thus serve to indicate the goal toward which development of motion picture projection should proceed and should also indicate what temporary compromises with that objective can be made most justifiably.

Mr. Evans noted the corollary position of the various television committees which have been searching for data in this same field. If their research covered all television viewing while the Screen Brightness Committee considered motion picture viewing, the data for the two fields would be complementary. For example, theater viewing probably covers the range of viewing distances from 1½ to 6 screen widths while television viewing begins at 6–7 screen widths and continues to greater distances.

DISCUSSION OF SIGNIFICANT VARIABLES

Most important to the outlining of a proper research program the discussion felt was a tabulation of significant variables in theater viewing so that proper account could be taken in setting up experiments. The conference enumerated the following variables as definitely significant: (1) screen brightness; (2) surround brightness; (3) conditioning level of illumination; (4) viewing angle; (5) viewing distance; and (6) subject matter of test pictures.

A primary contribution of the meeting was a discussion of these variables; the discussion has been taken out of its temporal sequence and here organized by subject.

1. Screen Brightness

Sensitivity of the observer to brightness changes was discussed, with Dr. Lozier and Mr. Chambers feeling that equal percentage changes in illumination are more visible at the lower brightness levels; for example at 2 ft-L a 100% increase in brightness appears more effective than a 100% increase at a level of 15 ft-L. Dr. Newhall suggested that the magnitude of such perception of brightness change is influenced greatly by the conditioning level of illumination preceding the test.

Color of the illuminant used during the test is important; Mr. Chambers reported that the optimum level chosen under incandescent illumination has been found to be different from that chosen under arc illumination and that in particular the apparent contrast of a picture appears higher with arc quality illumination. Mr. Evans agreed that the apparent contrast of the image varies considerably with the color of the illuminant.

Flicker inherent in the intermittent projection of motion pictures was discussed from two viewpoints: (1) the proper integration of an intermittently illuminated image, and (2) the perception of flicker as a distracting influence. The discussers felt that the indications of meters and measuring devices used to correlate work on screen brightness must be such as to have a response to intermittent illumination consistent with the response of the human eye. With reference to the level at which flicker becomes distracting, Dr. Lozier reported observations indicating that flicker is objectionable above 15–20 ft-L. Prof. O'Brien on the other hand found no objectionable flicker in his experiment[8] at levels up to 30 ft-L. Mr. Evans noted that while the threshold for foveal flicker is not exceeded by 48-cycle illumination at 30 ft-L, on the other hand the threshold for peripheral flicker at that intensity is well above 48 cycles. Peripheral flicker begins to be observed at 48 cycles in the range of 15 ft-L. Thus, the sensitivity to flicker and the effect of flicker as a disturbing influence will be a function of viewing angle, decreasing as the viewing angle is decreased and as the vision becomes more nearly limited to the foveal region.

2. Surround Brightness

Prof. O'Brien reported that in his opinion if his earlier research had made any single contribution it was to indicate that some definite surround brightness is desirable in the viewing of motion pictures, and that under normal theater conditions a surround brightness of approximately 0.05 ft-L is preferred by observers free to choose. Dr. Spragg reported that wartime research on radar-screen viewing showed significantly better performance of the observer with a definite surround brightness. There was less fatigue, better perception of detail, and quicker response to the image, as the surround brightness was progressively increased up to levels nearly equal to the screen brightness itself.

Mr. Evans pointed out that—entirely apart from the fatigue, ease, and pleasure of viewing—the surround-brightness

level changes the appearance of the picture; as the surround brightness is increased from zero up to the highlight brightness the illusion changes from that of viewing a projected picture to that of viewing a print.

Consequently, one factor influencing surround brightness is the determination of which viewing effect is desired and what criterion of desirability is chosen. Some of the newest theaters Evans noted are being so built as to use a graded surround illumination. Dr. Newhall pointed out that the "surround effect" depends very much upon the visual angle subtended by the screen and also upon the portion of the total visible angle that is covered by the "surround" under consideration.

3. Conditioning Level of Illumination

Dr. Newhall pointed out several times during the discussion that the results obtained in a study of vision such as is anticipated in this discussion, depend greatly upon the conditioning level of illumination. He stressed the importance of conducting the test with the observers conditioned in the manner of a practical theatre audience.

4. Viewing Angle

Dr. O'Brien in summarizing his previous experiments felt the outstanding defect was too restricted a viewing angle and pointed out that this defect was common to most of the early work on theater viewing. Dr. Spragg and Dr. Newhall in discussing the interrelationship between surround brightness and viewing angle pointed out the possibility that the optimum brightness may be a function of the viewing angle and that it should be so specified. Such a relationship might provide a basis for correlating indoor and outdoor theater recommendations.

Mr. Evans pointed out that committees of the television industry have been formulating questions similar to those proposed by the Screen Brightness Committee of the SMPTE, and that the scientific information desired by each group has much in common. For example, television viewing is very similar to motion picture screen viewing excepting that motion picture screen viewing angles are from $1\frac{1}{2}$ to perhaps 6 screen widths while television viewing begins at 6 screen diameters and continues to smaller angles. Dr. O'Brien suggested a cooperative research effort to determine the functions of television and motion picture viewing, spanning this angular range.

5. Viewing Distance

Mr. Evans suggested that the influence of viewing distance cannot be neglected even when viewing angles are duplicated, and he recommended that at least some of the experimental work be done under the actual viewing distances—in addition to small screen studies that duplicate viewing angles only. One effect of viewing distance, for example, may be to influence the comfort of the visual task.

6. Subject Matter of Pictures

Mr. Evans pointed out that it may be much more important to have a large number of test scenes rather than to have a large number of viewers. He pointed out, for example, that the British choice[4] of 7 ft-L for Technicolor and 12 ft-L for black-and-white viewing can easily result from a difference in the subject matter of the two film sections, rather than any fundamental difference in viewing. Mr. Evans and Dr. O'Brien proposed that by all means both color and black-and-white films be used.

There was at first a proposal that the viewing should duplicate actual conditions, employing a sound track along with the picture since that is the normal projection procedure. Mr. Evans and Mr. Weaver objected, however, pointing out that if sound affects vision, it will not be nearly so easy to judge how

pleasing the picture is if there is a simultaneous, possibly distracting, sound track. If other than the viewing task itself is examined, Dr. O'Brien pointed out, there will be no way of judging picture quality except by apparent fatigue, headache, etc. (Actually there seems to be no such thing as strictly visual fatigue, Dr. O'Brien pointed out, since the factors formerly attributed to "visual fatigue" are being explained by other factors entirely.)

Dr. O'Brien reported that the pictures for his experiment[8] were chosen purposely to have neither interest nor boredom, because it was necessary to project them a number of times in testing a single observer. The results in such a test, he pointed out, may be different from those that would be secured with an interesting picture viewed for the first time only. Dr. Newhall emphasized that pertinent research must be based upon typical films.

In the discussion of color versus black-and-white, Dr. Spragg asked whether the permissible brightness range might be more closely limited for color pictures. Mr. Evans pointed out that color prints cannot be projected with as high screen brightnesses as black-and-white prints without a shift in color balance. Most color processes tend to depart from balance in the deep shadows and the brightnesses must be kept low enough so that this departure is not obvious. The lower screen-brightness limits for acceptable image quality of both black-and-white and color appear to be equal.

The print density should correlate with release prints; Mr. Chambers pointed out that Mr. Tuttle's[14] early work on print density is no longer applicable because of the general change to fine-grain emulsions for black-and-white, and that therefore the measurements of current print densities should be repeated. The question was raised and left unanswered—whether the ultimate result of increased available screen brightness might not be a mere increase in print density. Mr. Chambers pointed out the commercial necessity for screen brightness uniformity such that the review-room brightnesses match the theater brightnesses, in order for the exhibitors to realize the kind of picture that is created by the directors and producers. Failure to keep this balance is responsible for the poor reception of some otherwise good pictures.

Nature of the Observer's Report

Dr. Spragg suggested that since the purpose of these experiments is to provide better theater viewing, the most important criterion is to meet the observer's preference. This type of judging was the basis of Dr. O'Brien's early experiments. Dr. Spragg suggested getting data from large-scale experiments such as a whole auditorium full of observers.

It is desirable, the group agreed, to get observers who are not self-conscious of their task. This is difficult to realize, however, and the use of repeated matter with fewer observers is an experimental risk that sometimes cannot be avoided.

Dr. Spragg suggested that in his experience it has been preferable to have untrained observers judge which of several conditions they prefer rather than to have them manipulate conditions to reach an optimum. Typical of this procedure, Dr. Spragg pointed out, is the CBS practice of equipping its studio audiences with "yes" or "no" push buttons which are summed electrically. The audience is asked to indicate its reaction to the show as it progresses, and the electrical summation gives a continuous record of show interest.

Mr. Weaver proposed audience sampling, giving cards to the patrons of actual theaters, on which they might indicate how they liked the performance and whether they would prefer to have had a brighter or dimmer picture. Such sampling can be done at successive

shows at varying screen brightnesses. Mr. Chambers suggested that audience background-noise level might be lower and applause- and laughter-level higher at the best projection brightness levels, therefore, a better method of audience sampling might be to record the audience-noise level—"applause meter reading"—in a theater where the screen brightness can be varied from one day to another. This recording meter program, he pointed out, is extensively used in Hollywood to judge previews, and there has been found a presumable relationship between audience enjoyment and audience-noise level. Dr. Spragg observed that the audience reaction to the pictures as judged by such meters is consistent and if an audience laughs for a given time at a particular part of the picture each audience will repeat with amazing reproducibility. Mr. Chambers pointed out that Mr. Sponable's group at 20th Century-Fox has used such meters in their West Coast preview theaters and that equipmentwise they are prepared to provide a range of screen brightnesses up to and beyond the usual levels. He suggested that 20th Century-Fox be invited to run such tests in their West Coast theaters now fitted with these applause meters, where on successive days of projecting the same program, the screen brightness would be varied and the day-to-day audience reaction compared. Such a comparison, Mr. Chambers pointed out, might give some very real and important data for answering the question of whether screen brightness is really important in judging the quality of a projected picture.

PROPOSED ACCOMPLISHMENTS

In the discussion it was pointed out that the present standard, while intended to be temporary, has functioned as a permanent standard for 15 years. During this time changes in equipment, films, theaters, etc. have been directed by the existence of this standard toward the maintenance of a constant screen brightness with variations in picture size, etc. It would be desirable, therefore, for fundamental research to indicate more clearly what optimum screen brightnesses should be, so that future technical improvements could be directed toward this optimum.

Even though present limitations might make it impossible for the optimum brightness to be realized and even though a working standard might have to compromise with this optimum, the existence of suitable basic data should make possible the best possible compromise. Accordingly the best attainable projection conditions would become the working standard, with future technical advances directed closer and closer to the optimum.

CONCLUSIONS

Consensus of opinion of this discussion was that a great deal of basic data on the factors influencing the viewing of projected pictures still remains to be determined. The conference agreed that it should be entirely practical for the Screen Brightness Committee to outline desirable research goals in such a manner that intelligent work directed toward their end would provide a real contribution to the science of viewing. Suitable explanatory matter, detailed outlines of procedures, and consultative guidance could be provided, the conference felt, to insure that such research programs may contribute basic knowledge and not unnecessarily further becloud the issue.

The conference felt that if the problems could be stated properly and succinctly, and if suitable guidance could be available, there might be a number of

groups willing to undertake the work as: (1) university research by students and staff members interested in the general field; or (2) industrial research sponsored by the companies interested in motion picture projection.

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Constitution of the Society of Motion Picture and Television Engineers

ARTICLE I
NAME

The name of this association shall be SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS.

ARTICLE II
OBJECTS

Its objects shall be: Advancement in the theory and practice of engineering in motion pictures, television, and the allied arts and sciences; the standardization of equipment and practices employed therein; the maintenance of a high professional standing among its members; and the dissemination of scientific knowledge by publication.

ARTICLE III
MEETINGS

There shall be an annual meeting and such other regular and special meetings as provided in the Bylaws.

ARTICLE IV
ELIGIBILITY FOR MEMBERSHIP

Any person of good character is eligible to become a member in any grade for which he is qualified in accordance with the Bylaws.

ARTICLE V
OFFICERS

The officers of the Society shall be a President, an Executive Vice-President, a Past-President, an Engineering Vice-President, an Editorial Vice-President, a Financial Vice-President, a Convention Vice-President, a Secretary, and a Treasurer.

The term of office of all elected officers shall be for a period of two years.

The President shall not be eligible to succeed himself in office.

At the conclusion of his term of office the President automatically becomes Past-President.

Under conditions as set forth in the Bylaws, the office of Executive Vice-President may be vacated before the expiration of his term.

A vacancy in any office shall be filled for the unexpired portion of the term in accordance with the Bylaws.

ARTICLE VI
SECTIONS

Sections may be established in accordance with the Bylaws.

ARTICLE VII
BOARD OF GOVERNORS

The Board of Governors shall consist of the President, the Past-President, the five Vice-Presidents, the Secretary, the Treasurer, the Section Chairmen, and twelve elected Governors. An equal number of these elected Governors shall reside within the areas included in the Eastern time zone; the Central time zone; and the Pacific and Mountain time zones. The term of office of all elected Governors shall be for a period of two years.

ARTICLE VIII
AMENDMENTS

This Constitution may be amended as follows: Amendments may originate as recommendations within the Board of Governors, or as a proposal to the Board of Governors, by any ten members of voting grade; when approved by the Board of Governors as set forth in the Bylaws, the proposed amendment shall then be submitted for discussion at the annual meeting or at a regular or special meeting called as provided in the Bylaws. The proposed amendment, together with the discussion thereon, shall then be promptly submitted by mail to all members qualified to vote, as set forth in the Bylaws. Voting shall be by letter ballot mailed with the proposed amendment and discussion to the voting membership. In order to be counted, returned ballots must be received within sixty (60) days of the mailing-out date. An affirmative vote of two thirds of the valid ballots returned, subject to the above time limitations, shall be required to carry the amendment, provided one fifteenth of the duly qualified members shall have voted within the time limit specified herein.

BYLAWS OF THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

BYLAW I

MEMBERSHIP

Sec. 1. Membership of the Society shall consist of the following grades: Honorary members, Sustaining members, Fellows, Active members, Associate members and Student members.

An *Honorary member* is one who has performed eminent service in the advancement of engineering in motion pictures, television, or allied arts. An Honorary member shall be entitled to vote and to hold any office in the Society.

A *Sustaining member* is an individual, company, or corporation subscribing substantially to the financial support of the Society.

A *Fellow* is one who shall be not less than thirty years of age and who shall by his proficiency and contributions have attained to an outstanding rank among engineers or executives of the motion picture or television industries. A Fellow shall be entitled to vote and to hold any office in the Society.

An *Active member* is one who shall be not less than twenty-five years of age and shall be or shall have been either one or an equivalent combination of the following:

(a) An engineer or scientist in motion picture, television or allied arts. As such he shall have performed and taken responsibility for important engineering or scientific work in these arts and shall have been in the active practice of his profession for at least three years, or

(b) A teacher of motion picture, television or allied subjects for at least six years in a school of recognized standing in which he shall have been conducting a major course in at least one of such fields, or

(c) A person who by invention or by contribution to the advancement of engineering or science in motion picture, television or allied arts, or to the technical literature thereof, has attained a standing equivalent to that required for Active membership in (a), or

(d) An executive who for at least three years has had under his direction important engineering or responsible work in the motion picture, television or allied industries and who is qualified for direct supervision of the technical or scientific features of such activities. An Active member shall be entitled to vote and to hold any office in the Society.

An *Associate member* is one who shall be not less than eighteen years of age, and shall be a person who is interested in the study of motion picture or television technical problems or connected with the application of them. An Associate member is not privileged to vote, to hold office or to act as chairman of any committee, although he may serve upon any committee to which he may be appointed; and, when so appointed, shall be entitled to the full voting privileges on action taken by the committee.

A *Student member* is any person registered as a student, graduate or undergraduate, in a college, university, or other educational institution of like scholastic standing, who evidences interest in motion picture or television technology. Membership in this grade shall not extend more than one year beyond the termination of the student status described above. A student member shall have the same privileges as an Associate member of the Society.

Sec. 2. All applications for membership or transfer should be made on blank forms provided for the purpose, and shall give a complete record of the applicant's education and experience. Honorary and Fellow grades may not be applied for.

Sec. 3. (a) Honorary membership may be granted upon recommendation of the Honorary Membership Committee when confirmed first by a three-fourths majority vote of those present at a meeting of the Board of Governors, and then by a four-fifths majority vote of all voting members present at any regular meeting or at a special meeting called as stated in the bylaws. An Honorary member shall be exempt from the payment of all dues.

(b) Upon recommendation of the Fellow Award Committee, when confirmed by a three-fourths majority vote by those present at a meeting of the Board of Governors, an Active member may be made a Fellow.

(c) An Applicant for Active membership shall give as references at least two mem-

bers of the grade applied for or of a higher grade. Applicants shall be elected to membership by a three-fourths majority vote of the entire membership of the appropriate Admissions Committee. An applicant may appeal to the Board of Governors if not satisfied with the action of the Admissions Committee, in which case approval of at least three-fourths of those present at a meeting of the Board of Governors shall be required for election to membership or to change the action taken by the Admissions Committee.

(d) An applicant for Associate membership shall give as reference one member of the Society, or two persons not members of the Society who are associated with the motion picture, television, or allied industry. Applicants shall be elected to membership by approval of the Chairman of the appropriate Admissions Committee.

(e) An applicant for Student membership shall be sponsored by a member of the Society, or by a member of the staff of the department of the institution he is attending, this faculty member not necessarily being a member of the Society. Applicants shall be elected to membership by approval of the Chairman of the appropriate admissions committee.

Sec. 4. Any member may be suspended or expelled for cause by a majority vote of the entire Board of Governors, provided he shall be given notice and a copy in writing of the charges preferred against him, and shall be afforded opportunity to be heard ten days prior to such action.

BYLAW II

OFFICERS

Sec. 1. An officer or governor shall be an Honorary member, Fellow, or an Active member.

BYLAW III

BOARD OF GOVERNORS

Sec. 1. The Board of Governors shall transact the business of the Society in accordance with the Constitution and Bylaws.

Sec. 2. The Board of Governors may act on special resolutions between meetings, by letter ballot authorized by the President. An affirmative vote from a majority of the total membership of the Board of Governors shall be required for approval of such resolutions.

Sec. 3. A quorum of ten members of the Board of Governors shall be present to vote on resolutions presented at any meeting. Unless otherwise specified, a majority vote of the Governors present shall constitute approval of a resolution.

Sec. 4. A member of the Board of Governors may not authorize an alternate to act or vote in his stead.

Sec. 5. Vacancies in the offices or on the Board of Governors shall be filled by the Board of Governors until the annual elections of the Society.

Sec. 6. The Board of Governors, when filling vacancies in the offices or on the Board of Governors, shall endeavor to appoint persons who in the aggregate are representative of the various branches or organizations of the industries interested in the activities of the Society to the end that there shall be no substantial predominance upon the Board, as the result of its own action, of representatives of any one or more branches or organizations of such industries.

Sec. 7. The time and place of all except special meetings of the Board of Governors shall be determined by the Board of Governors.

Sec. 8. Special Meetings of the Board of Governors shall be called by the President with the proviso that no meeting shall be called without at least seven days prior notice to all members of the Board by letter or telegram. Such a notice shall state the purpose of the meeting.

BYLAW IV

ADMINISTRATIVE PRACTICES

Sec. 1. Special rules relating to the administration of the Society and known as Administrative Practices shall be established by the Board of Governors and shall be added to or revised as necessary to the efficient pursuit of the Society's objectives.

BYLAW V

COMMITTEES

Sec. 1. All committees, except as otherwise specified, shall be formed and appointed in accordance with the Administrative Practices as determined by the Board of Governors.

Sec. 2. All committees, except as otherwise specified, shall be appointed to act for the term served by the officer charged with appointing the committees or until he terminates the appointment.

Sec. 3. Chairmen of the committees shall not be eligible to serve in such capacity for more than two consecutive terms.

Sec. 4. Standing Committees of the Society to be appointed by the President and confirmed by the Board of Governors are as follows:

Honorary Membership Committee
Journal Award Committee
Nominating Committee
Progress Medal Award Committee
Public Relations Committee
Samuel L. Warner Memorial Award Committee

Sec. 5. There shall be an Admissions Committee for each Section of the Society composed of a chairman and three members of which at least two shall be members of the Board of Governors.

Sec. 6. There shall be a Fellow Award Committee composed of all the officers and section chairmen of the Society under the chairmanship of the Past-President. In case the chairmanship is vacated it shall be temporarily filled by appointment by the President.

BYLAW VI

MEETINGS OF THE SOCIETY

Sec. 1. The location and time of each meeting or convention of the Society shall be determined by the Board of Governors.

Sec. 2. The grades of membership entitled to vote are defined in Bylaw I.

Sec. 3. A quorum of the Society shall consist in number of $\frac{1}{15}$ of the total of those qualified to vote as listed in the Society's records at the close of the last fiscal year before the meeting.

Sec. 4. The annual meeting shall be held during the fall convention.

Sec. 5. Special meetings may be called by the President and upon the request of any three members of the Board of Governors not including the President.

Sec. 6. All members of the Society in any grade shall have the privilege of discussing technical material presented before the Society or its Sections.

BYLAW VII

DUTIES OF OFFICERS

Sec. 1. The President shall preside at all business meetings of the Society and shall perform the duties pertaining to that office. As such he shall be the chief executive of the Society, to whom all other officers shall report.

Sec. 2. In the absence of the President, the officer next in order as listed in Article V of the Constitution shall preside at meetings and perform the duties of the President.

Sec. 3. The seven officers shall perform the duties separately enumerated below and those defined by the President:

(a) The Executive Vice-President shall represent the President, and shall be responsible for the supervision of the general affairs of the Society as directed by the President.

The President and the Executive Vice-President shall not both reside in the geographical area of the same Society Section, but one of these officers shall reside in the vicinity of the executive offices. Should the President or Executive Vice-President remove his residence to the same geographical area of the United States as the other, the office of Executive Vice-President shall immediately become vacant and a new Executive Vice-President shall be elected by the Board of Governors for the unexpired portion of the term.

(b) The Engineering Vice-President shall appoint all technical committees. He shall be responsible for the general initiation, supervision, and co-ordination of the work of these committees.

(c) The Editorial Vice-President shall be responsible for the publication of the Society's *Journal* and all other Society publications.

(d) The Financial Vice-President shall be responsible for the financial operations of the Society, and shall conduct them in accordance with budgets prepared by him and approved by the Board of Governors.

(e) The Convention Vice-President shall be responsible for the national conventions of the Society. He shall arrange for at least one annual convention to be held in the fall of the year.

Sec. 4. The Secretary shall keep a record of all meetings; and shall have the responsibility for the care and custody of records, and the seal of the Society.

Sec. 5. The Treasurer shall have charge of the funds of the Society and disburse them as and when authorized by the Financial Vice-President. He shall be bonded in an amount to be determined by the Board of Governors, and his bond shall be filed with the Secretary.

Sec. 6. Each officer of the Society, upon the expiration of his term of office, shall

transmit to his successor a memorandum outlining the duties and policies of his office.

BYLAW VIII

SOCIETY ELECTIONS

Sec. 1. All officers and governors shall be elected to their respective offices by a majority of ballots cast by voting members in the following manner:

Nominations shall first be presented by a Nominating Committee appointed by the President, consisting of nine members, including a Chairman. The committee shall be made up of two Past-Presidents, three members of the Board of Governors not up for election, and four other voting members, not currently officers or governors of the Society. Nominations shall be made by three-quarters affirmative vote of the total Nominating Committee.

Not less than three months prior to the Annual Fall Meeting, the Board of Governors shall review the recommendations of the Nominating Committee, which shall have nominated suitable candidates for each vacancy.

Such nominations shall be final unless any nominee is rejected by a three-quarters vote of the Board of Governors present and voting. The Secretary shall then notify these candidates of their nomination. From the list of acceptances, not more than three names for each vacancy shall be selected by the Board of Governors and placed on a letter ballot. A blank space shall be provided on this letter ballot under each office, in which space the name of any voting member other than those suggested by the Board of Governors may be voted for. The balloting shall then take place. The ballot shall be enclosed with a blank envelope and a business reply envelope bearing the Secretary's address and a space for the member's name and address. One set of these shall be mailed to each voting member of the Society, not less than forty days in advance of the annual fall meeting.

The voter shall then indicate on the ballot one choice for each vacancy, seal the ballot in the blank envelope, place this in the envelope addressed to the Secretary, sign his name and address on the latter, and mail it in accordance with the instructions printed on the ballot. No marks of any kind except those above prescribed shall be placed upon the ballots or envelopes. Voting shall close seven days before the opening session of the annual fall convention.

The sealed envelope shall be delivered by the Secretary to a Committee of Tellers appointed by the President at the annual fall convention. This committee shall then examine the return envelopes, open and count the ballots, and announce the results of the election.

The newly-elected officers and governors of the Society shall take office on January 1, following their election.

BYLAW IX

DUES AND INDEBTEDNESS

Sec. 1. The annual dues shall be fifteen dollars ($15) for Fellows and Active members, ten dollars ($10) for Associate members, and five dollars ($5) for Student members, payable on or before January 1, of each year. Current or first year's dues for new members in any calendar year shall be at the full annual rate for those notified of election to membership on or before June 30; one half the annual rate for those notified of election to membership in the Society on or after July 1.

Sec. 2. (a) Transfer of membership to a higher grade may be made at any time subject to the requirements for initial membership in the higher grade. If the transfer is made on or before June 30, the annual dues of the higher grade are required. If the transfer is made on or after July 1, and the member's dues for the full year have been paid, one half of the annual dues of the higher grade is payable less one half the annual dues of the lower grade.

(b) No credit shall be given for annual dues in a membership transfer from a higher to a lower grade, and such transfers shall take place on January 1, of each year.

Sec. 3. Annual dues shall be paid in advance.

Sec. 4. Failure to pay dues may be considered just cause for suspension.

BYLAW X

PUBLICATIONS

Sec. 1. The Society shall publish a technical magazine to consist of twelve monthly issues, in two volumes per year. The editorial policy of the *Journal* shall be based upon the provisions of the Constitution and a copy of each issue shall be supplied to each member in good standing mailed to his last address of record.

Copies may be made available for sale at a price approved by the Board of Governors.

BYLAW XI

LOCAL SECTIONS

Sec. 1. Sections of the Society may be authorized in any locality where the voting membership exceeds twenty. The geographic boundaries of each Section shall be determined by the Board of Governors. Upon written petition for the authorization of a Section of the Society, signed by twenty or more voting members, the Board of Governors may grant such authorization.

SECTION MEMBERSHIP

Sec. 2. All members of the Society of the Motion Picture and Television Engineers in good standing residing within the geographic boundaries of any local Section shall be considered members of that Section.

Sec. 3. Should the enrolled voting membership of a Section fall below twenty, or should the technical quality of the presented papers fall below an acceptable level, or the average attendance at meetings not warrant the expense of maintaining that Section, the Board of Governors may cancel its authorization.

SECTION OFFICERS

Sec. 4. The officers of each Section shall be a Chairman and a Secretary-Treasurer. The Section chairmen shall be ex-officio members of the Board of Governors and shall continue in such positions for the duration of their terms as chairmen of the local Sections. Each Section officer shall hold office for one year, or until his successor is chosen.

SECTION BOARD OF MANAGERS

Sec. 5. The Board of Managers shall consist of the Section Chairman, the Section Past-Chairman, the Section Secretary-Treasurer, and six voting members. Each manager of a Section shall hold office for two years. Vacancies shall be filled by appointment by the Board of Managers until the annual election of the Section.

SECTION ELECTIONS

Sec. 6. The officers and managers of a Section shall be voting members of the Society. All officers and managers shall be elected to their respective offices by a majority of ballots cast by the voting members residing in the geographical area of the Section. Not less than three months prior to the annual fall convention of the Society, nominations shall be presented to the Board of Managers of the Section by a Nominating Committee appointed by the Chairman of the Section, consisting of seven members, including a chairman. The committee shall be composed of the present Chairman, the Past-Chairman, two other members of the Board of Managers not up for election, and three other voting members of the Section not currently officers or managers of the Section. Nominations shall be made by a three-quarters affirmative vote of the total Nominating Committee. Such nominations shall be final, unless any nominee is rejected by a three-quarters vote of the Board of Managers, and in the event of such rejection the Board of Managers will make its own nomination.

The Chairman of the Section shall then notify the candidates of their nomination. From the list of acceptances, not more than three names for each vacancy shall be selected by the Board of Managers and placed on a letter ballot. A blank space shall be provided on this letter ballot under each office, in which space the name of any voting member other than those suggested by the Board of Managers may be voted for. The balloting shall then take place. The ballot shall be enclosed with a blank envelope and a business reply envelope bearing the local Secretary-Treasurer's address and a space for the member's name and address. One of these shall be mailed to each voting member of the Society residing in the geographical area covered by the Section, not less than forty days in advance of the annual fall convention.

The voter shall then indicate on the ballot one choice for each office, seal the ballot in the blank envelope, place this in the envelope addressed to the Secretary-Treasurer, sign his name and address on the latter, and mail it in accordance with the instructions printed on the ballot. No marks of any kind except those above prescribed shall be placed upon the ballots or envelopes. Voting shall close seven days before the opening session of the annual fall convention. The sealed envelopes shall be delivered by the Secretary-Treasurer to his Board of Managers at a

duly called meeting. The Board of Managers shall then examine the returned envelopes, open and count the ballots, and announce the results of the election.

The newly-elected officers and managers shall take office on January 1, following their election.

SECTION BUSINESS

Sec. 7. The business of a Section shall be conducted by the Board of Managers.

SECTION EXPENSES

Sec. 8. (a) At the beginning of each fiscal year, the Secretary-Treasurer of each section shall submit to the Board of Governors of the Society a budget of expenses for the year.

(b) The Treasurer of the Society shall deposit with each Section Secretary-Treasurer a sum of money for current expenses, the amount to be fixed by the Board of Governors.

(c) The Secretary-Treasurer of each Section shall send to the Treasurer of the Society, quarterly or on demand, an itemized account of all expenditures incurred during the preceding period.

(d) Expenses other than those enumerated in the budget, as approved by the Board of Governors of the Society, shall not be payable from the general funds of the Society without express permission from the Board of Governors.

(e) The Section Board of Managers shall defray all expenses of the Section not provided for by the Board of Governors, from funds raised locally.

(f) The Secretary of the Society shall, unless otherwise arranged, supply to each Section all stationery and printing necessary for the conduct of its business.

SECTION MEETINGS

Sec. 9. The regular meetings of a Section shall be held in such places and at such hours as the Board of Managers may designate. The Secretary-Treasurer of each Section shall forward to the Secretary of the Society, not later than five days after a meeting of a Section, a statement of the attendance and of the business transacted.

CONSTITUTION AND BYLAWS

Sec. 10. Sections shall abide by the Constitution and Bylaws of the Society and conform to the regulations of the Board of Governors. The conduct of Sections shall always be in conformity with the general policy of the Society as fixed by the Board of Governors.

BYLAW XII

STUDENT CHAPTERS

Sec. 1. Student Chapters of the Society may be authorized in any college, university, or technical institute of collegiate standing. Upon written petition for the authorization of a Student Chapter, signed by twelve or more Society members, or applicants for Society membership, and the Faculty Adviser, the Board of Governors may grant such authorization.

CHAPTER MEMBERSHIP

Sec. 2. All members of the Society in good standing who are attending the designated educational institution shall be eligible for membership in the Student Chapter, and when so enrolled they shall be entitled to all privileges that such Student Chapter may, under the Constitution and Bylaws, provide.

Sec. 3. Should the membership of the Student Chapter fall below ten, or the average attendance at meetings not warrant the expense of maintaining the organization, the Board of Governors may cancel its authorization.

CHAPTER OFFICERS

Sec. 4. The officers of each Student Chapter shall be a Chairman and a Secretary-Treasurer. Each Chapter officer shall hold office for one year, or until his successor is chosen. Where possible, officers shall be chosen in May to take office at the beginning of the following school year. The procedure for holding elections shall be prescribed in Administrative Practices.

FACULTY ADVISER

Sec. 5. A member of the faculty of the same educational institution shall be designated by the Board of Governors as Faculty Adviser. It shall be his duty to advise the officers on the conduct of the Chapter and to approve all reports to the Secretary and the Treasurer of the Society.

CHAPTER EXPENSES

Sec. 6. The Treasurer of the Society shall deposit with each Chapter Secretary-Treasurer a sum of money, the amount to be fixed by the Board of Governors. The Secretary-Treasurer of the Chapter shall send to the Treasurer of the Society at the

end of each school year or on demand an itemized account of all expenditures incurred.

CHAPTER MEETINGS

Sec. 7. The Chapter shall hold at least four meetings per year. The Secretary-Treasurer shall forward to the Secretary of the Society at the end of each school year a report of the meetings for that year, giving the subject, speaker, and approximate attendance for each meeting.

BYLAW XIII

AMENDMENTS

Sec. 1. Proposed amendments to these Bylaws may be initiated by the Board of Governors or by a recommendation to the Board of Governors signed by ten voting members. Proposed amendments may be approved at any regular meeting of the Society at which a quorum is present, by the affirmative vote of two-thirds of the members present and eligible to vote thereon. Such proposed amendments shall have been published in the *Journal* of the Society, in the issue next preceding the date of the stated business meeting of the Society at which the amendment or amendments are to be acted upon.

Sec. 2. In the event that no quorum of the voting members is present at the time of the meeting referred to in Sec. 1, the amendment or amendments shall be referred for action to the Board of Governors. The proposed amendment or amendments then become a part of the Bylaws upon receiving the affirmative vote of three-quarters of the entire membership of the Board of Governors.

OFFICERS OF THE SOCIETY April, 1951

Herbert Barnett
Executive Vice-President
1951–52

Peter Mole
President
1951–52

Earl I. Sponable
Past-President
1951–52

Fred T. Bowditch
Engineering Vice-President
1950–51

John G. Frayne
Editorial Vice-President
1951–52

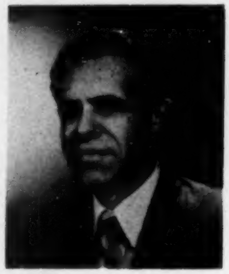
Ralph B. Austrian
Financial Vice-President
1950–51

William C. Kunzmann
Convention Vice-President
1951–52

Robert M. Corbin
Secretary
1951–52

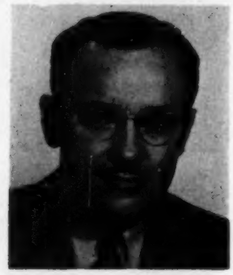
FRANK E. CAHILL, JR.
Treasurer, 1950–51

PAUL J. LARSEN
Governor, 1950–51



LORIN D. GRIGNON
Governor, 1950–51

WILLIAM H. RIVERS
Governor, 1950–51



R. T. VAN NIMAN
Governor, 1950–51

EDWARD S. SEELEY
Governor, 1950–51

FRANK E. CARLSON
Governor, 1951–52

THOMAS T. MOULTON
Governor, 1951–52

WILLIAM B. LODGE
Governor, 1951–52

NORWOOD L. SIMMONS
Governor, 1951–52

OSCAR F. NEU
Governor, 1951–52

Malcolm G. Townsley
Governor, 1951–52

Lloyd Thompson
Governor, 1951–52

George W. Colburn
Governor, 1951

Charles R. Daily
Governor, 1951

E. M. Stifle
Governor, 1951

OFFICERS AND MANAGERS OF SECTIONS

ATLANTIC COAST: *Chairman*, E. M. Stifle; *Secretary-Treasurer*, H. C. Milholland; *Managers*, E. A. Bertram, H. D. Bradbury, H. A. Chinn, E. Dudley Goodale, D. B. Joy, R. G. Mann

CENTRAL: *Chairman*, G. W. Colburn; *Secretary-Treasurer*, C. E. Heppberger; *Managers*, E. E. Bickel, E. W. D'Arcy, R. E. Lewis, H. T. Nuttall, Lloyd Thompson, M. G. Townsley

PACIFIC COAST: *Chairman*, C. R. Daily; *Secretary-Treasurer*, Vaughan Shaner; *Managers*, L. W. Aicholtz, F. G. Albin, L. D. Grignon, W. F. Kelley, R. E. Lovell, E. H. Reichard

STUDENT CHAPTER OFFICERS

NEW YORK UNIVERSITY: *Chairman*, William F. Boden; *Secretary-Treasurer*, Gerald I. Rosenfeld

UNIVERSITY OF SOUTHERN CALIFORNIA: *Chairman*, Melvin R. Kells; *Secretary-Treasurer*, Eric T. Sjolander

Melvin R. Kells
Chairman, University of Southern California

William F. Boden
Chairman,
New York University

Treasurer's Report

January 1—December 31, 1950

Cash		
Cash on Deposit, Chase National Bank, January 1, 1950	$ 6,131.44	
Net Receipts	23,962.48	
Cash on Deposit—December 31, 1950	30,093.92	
Petty Cash Fund	200.00	
Total Cash on Hand and in Bank		$ 30,293.92
Investments		
Savings Accounts, January 1, 1950	$15,704.36	
Add: Additional Investments	15,000.00	
Interest Credited	715.35	
Savings Accounts, December 31, 1950	31,419.71	
U.S. Government Bonds (at cost)	60,000.00	
Total Investments		91,419.71
Total Cash and Investments, December 31, 1950		$121,713.63

Respectfully submitted,
FRANK E. CAHILL, JR., *Treasurer*

Summary of Financial Condition

December 31, 1950

Assets (What Your Society Owns)	
Cash on Hand and in Bank	$ 30,293.92
Savings Accounts	31,419.71
U.S. Government Bonds (at cost)	60,000.00
Accounts Receivable	8,349.99
Test Film Inventory	4,874.91
Test Film Equipment (depreciated value)	3,730.85
Office Furniture and Equipment (memo value)	1.00
Prepaid Expenses	46.88
Total Assets	$138,717.26
Liabilities (What Your Society Owes)	
Accounts Payable	$ 4,814.21
Due to Customers	430.19
Membership Dues Received in Advance	13,675.61
N.Y.C. Sales Tax Payable	9.18
Reserve for 1950 Five-Year Index	2,500.00
Total Liabilities	$ 21.429.19
Members' Equity (What Your Society Is Worth)	117,288.07
Total Liabilities and Members' Equity	$138,717.26

Statement of Income and Expenses

January 1—December 31, 1950

Test Film Operations		
Total Test Film Sales	$88,468.77	
Cost of Test Films Sold	46,616.71	
Net Income From Test Film Operations		$41,852.06
Publications Operations		
Total Publications Income	$18,989.38	
Total Cost of Publications	36,536.36	
Net Loss From Publications Operations		(17,546.98)
Other Operations		
Income From Other Operations	$ 821.95	
Cost of Other Operations	969.15	
Net Loss From Other Operations		(147.20)
Other Income		
Membership Dues		59,358.81
Interest Earned		2,165.35
Total Operating Income		$85,682.04
Operating Expenses		
Engineering	$10,015.09	
Non-Engineering	2,229.66	
Administrative	39,249.60	
Officers	94.75	
Sections and Chapters	2,250.00	
Affiliations	1,135.00	
Conventions (Net)	(498.98)	
Total Operating Expenses		54,475.12
Net Operating Income		$31,206.92
Other Deductions		
Depreciation of Test Film Equipment	$ 3,730.86	
Provision for 1950 Five-Year Index	500.00	
Total Other Deductions		4,230.86
Excess of Income over Expenses		$26,976.06

THE FOREGOING financial statements were prepared from the records of the Society for the year 1950 and reflect the results of operations for that year. The records and financial statements were audited for the year ended December 31, 1950, by Wilbur A. Smith, Certified Public Accountant, New York City, and are in conformity with that audit.

RALPH B. AUSTRIAN, Financial Vice-President

Membership Report

For Year Ended December 31, 1950

	Hon.	Sust.	Fel.	Act.	Assoc.	Stud.	Total
Membership, January 1, 1950	2	67	187	871	1800	220	3147
New Members	1	12		134	237	80	464
Reinstatements		9	3	5	8	1	26
	3	88	190	1010	2045	301	3637
Resignations		−5		−22	−15	−11	−53
Deceased			−2	−5	−2		−9
Delinquents		−4	−1	−59	−145	−83	−292
	3	79	187	924	1883	207	3283
Changes in Grade:							
Fellow to Honorary	1		−1				
Active to Fellow			13	−13			
Associate to Active				21	−21		
Student to Active				3		−3	
Student to Associate					21	−21	
Fellow to Active			−1	1			
Active to Associate				−4	4		
Active to Student				−1		1	
Membership, December 31, 1950	4	79	198	931	1887	184	3283

Nonmember Subscription Report

For Year Ended December 31, 1950

Subscriptions, January 1, 1950	488
New Subscriptions	718
	1206
Cutoffs and Expirations	631
Subscriptions, December 31, 1950	575

Awards

IN ACCORDANCE with the provisions of the Administrative Practices of the Society and the regulations for granting the Journal Award, the Progress Medal Award and the Samuel L. Warner Memorial Award, a list of names of previous recipients and the reasons for the awards are published annually in the JOURNAL as follows:

Journal Award

The Journal Award Committee shall consist of five Fellows or Active members of the Society, appointed by the President and confirmed by the Board of Governors. The Chairman of the Committee shall be designated by the President.

At the fall convention of the Society a Journal Award Certificate shall be presented to the author or to each of the authors of the most outstanding paper originally published in the JOURNAL of the Society during the preceding calendar year.

Other papers published in the JOURNAL of the Society may be cited for Honorable Mention at the option of the Committee, but in any case should not exceed five in number.

The Journal Award shall be made on the basis of the following qualifications:

(1) The paper must deal with some technical phase of motion picture engineering.

(2) No paper given in connection with the receipt of any other Award of the Society shall be eligible.

(3) In judging of the merits of the paper, three qualities shall be considered, with the weights here indicated: (a) technical merit and importance of material, 45%; (b) originality and breadth of interest, 35%; and (c) excellence of presentation of the material, 20%.

A majority vote of the entire Committee shall be required for the election to the Award. Absent members may vote in writing.

The report of the Committee shall be presented to the Board of Governors at their July meeting for ratification.

These regulations, a list of the names of those who have previously received the Journal Award, the year of each Award, and the titles of the papers shall be published annually in the JOURNAL of the Society. In addition, the list of papers selected for Honorable Mention shall be published in the JOURNAL of the Society during the year current with the Award.

The recipients are listed below by year, with the date of JOURNAL publication given after the title.

1934, P. A. Snell, "An introduction to the experimental study of visual fatigue," May 1933.

1935, L. A. Jones and J. H. Webb, "Reciprocity law failure in photographic exposure," Sept. 1934.

1936, E. W. Kellogg, "A comparison of variable-density and variable-width systems," Sept. 1935.

1937, D. B. Judd, "Color blindness and anomalies of vision," June 1936.

1938, K. S. Gibson, "The analysis and specification of color," Apr. 1937.

1939, H. T. Kalmus, "Technicolor adventures in cinemaland," Dec. 1938.

1940, R. R. McNath, "The surface of the nearest star," Mar. 1939.

1941, J. G. Frayne and Vincent Pagliarulo, "The effects of ultraviolet light on variable-density recording and printing," June 1940.

1942, W. J. Albersheim and Donald MacKenzie, "Analysis of soundfilm drives," July 1941.

1943, R. R. Scoville and W. L. Bell, "Design and use of noise-reduction bias systems," Feb. 1942 (Award made Apr. 1944).

1944, J. I. Crabtree, G. T. Eaton and M. E. Muehler, "Removal of hypo and silver salts from photographic materials as affected by the composition of the processing solutions," July 1943.

1945, C. J. Kunz, H. E. Goldberg and C. E. Ives, "Improvement in illumination efficiency of motion picture printers," May 1944.

1946, R. H. Talbot, "The projection life of film," Aug. 1945.

1947, Albert Rose, "A unified approach to the performance of photographic film, television pickup tubes, and the human eye," Oct. 1946.

1948, J. S. Chandler, D. F. Lyman and L. R. Martin, "Proposals for 16-mm and 8-mm sprocket standards," June 1947.

1949, F. G. Albin, "Sensitometric aspect of television monitor-tube photography," Dec. 1948.

1950, Frederick J. Kolb, Jr., "Air Cooling of Motion Picture Film for Higher Screen Illumination," Dec. 1949.

The present Chairman of the Journal Award Committee is Frederick J. Kolb, Jr.

Progress Medal Award

The Progress Medal Award Committee shall consist of five Fellows or Active members of the Society, appointed by the President and confirmed by the Board of Governors. The Chairman of the Committee shall be designated by the President.

The Progress Medal may be awarded each year to an individual in recognition of any invention, research or development which, in the opinion of the Committee, shall have resulted in a significant advance in the development of motion picture technology.

Any member of the Society may recommend persons deemed worthy of the Award. The recommendation in each case shall be in writing and in detail as to the accomplishments which are thought to justify consideration. The recommendation shall be seconded in writing by any two Fellows or Active members of the Society, who shall set forth their knowledge of the accomplishments of the candidate which, in their opinion, justify consideration.

A majority vote of the entire Committee shall be required to constitute an Award of the Progress Medal. Absent members may vote in writing.

The report of the Committee shall be presented to the Board of Governors at their July meeting for ratification.

The recipient of the Progress Medal shall be asked to present a photograph of himself to the Society and, at the discretion of the Committee, may be asked to prepare a paper for publication in the JOURNAL of the Society.

These regulations, a list of the names of those who have previously received the Medal, the year of each Award and a statement of the reason for the Award shall be published annually in the JOURNAL of the Society.

Awards have been made as follows:

1935, E. C. Wente, for his work in sound recording and reproduction, Dec. 1935.

1936, C. E. K. Mees, for his work in photography, Dec. 1936.

1937, E. W. Kellogg, for his work in sound reproduction, Dec. 1937.

1938, H. T. Kalmus, for his work in developing color motion pictures, Dec. 1938.

1939, L. A. Jones, for his scientific researches in photography, Dec. 1939.

1940, Walt Disney, for his contributions to motion picture photography and sound recording of feature and short cartoon films, Dec. 1940.

1941, G. L. Dimmick, for his development activities in motion picture sound recording, Dec. 1941.

No Awards were made in 1942 and 1943.

1944, J. G. Capstaff, for his research and development of films and apparatus used in amateur cinematography, Jan. 1945.

No Awards were made in 1945 and 1946.

1947, J. G. Frayne, for his technical achievements and the documenting of his work in addition to his contributions to the field of education and his inspiration to his fellow engineers, Jan. 1948.

1948, Peter Mole for his outstanding achievements in motion picture studio lighting which set a pattern for lighting techniques and equipment for the American motion picture industry, Jan. 1949.

1949, Harvey Fletcher for his outstanding contributions to the art of recording and reproducing of sound for motion pictures, Oct. 1949.

1950, V. K. Zworykin, for his outstanding contributions to the development of television, Dec. 1950.

The present Chairman of the Progress Medal Award Committee is D. B. Joy.

Samuel L. Warner Memorial Award

Each year the President shall appoint a Samuel L. Warner Memorial Award Committee consisting of a chairman and four members. The chairman and committee members must be Active Members or Fellows of the Society. In considering candidates for the Award, the committee shall give preference to inventions or developments occurring in the last five years. Preference should also be given to the invention or development likely to have the widest and most beneficial effect on the quality of the reproduced sound and picture. A description of the method or apparatus must be available for publication in sufficient detail so that it may be followed by anyone skilled in the art. Since the Award is made to an individual, a development in which a group participates should be considered only if one person has contributed the basic idea and also has contributed substantially to the practical working out of the idea. If, in any year, the committee does not consider any recent development to be more than the logical working out of details along well-known lines, no recommendation for the Award shall be made. The recommendation of the committee shall be presented to the Board of Governors at the July meeting.

The purpose of this Award is to encourage the development of new and improved methods or apparatus designed for sound-on-film motion pictures, including any step in the process.

Any person, whether or not a member of the Society of Motion Picture and Televison Engineers, is eligible to receive the Award.

The Award shall consist of a gold medal suitably engraved for each recipient. It shall be presented at the Fall Convention of the Society, together with a bronze replica.

These regulations, a list of those who previously have received the Award, and a statement of the reason for the Award shall be published annually in the Journal of the Society. The recipients have been:

1947, J. A. Maurer, for his outstanding contributions to the field of high-quality 16-mm sound recording and reproduction, film processing, development of 16-mm sound test films, and for his inspired leadership in industry standardization (citation published, Jan. 1948).

1948, Nathan Levinson, for his outstanding work in the field of motion picture sound recording, the intercutting of variable-area and variable-density sound tracks, the commercial use of control track for extending volume range, and the use of the first soundproof camera blimps (citation published, Jan. 1949).

1949, R. M. Evans, for his outstanding work in the field of color motion picture films, including research on visual effects in photography and development work on commercial color processes (citation published, Oct. 1949).

1950, Charles R. Fordyce, for his efforts and the achievement of the development of triacetate safety base film (citation published, Dec. 1950).

The present Chairman of the Samuel L. Warner Memorial Award Committee is Glenn L. Dimmick.

Addendum—1951 Nominations

'Voting' members of the Society should note that in addition to those listed on p. 250 of the February Journal, there should be the office of Engineering Vice-President, of which Fred T. Bowditch is the incumbent.

Journals Out of Stock: The Society's stock of Journal issues for March, Part II, July, August, September, 1949, and February, 1950, has been exhausted as a result of an unexpected increase in demand and the Society's Headquarters is anxious to purchase a stock of each. Members or libraries having extra copies available are invited to send them in. The going price is 75c.

Engineering Activities

TV Studio Lighting

Members of the Television Studio Lighting Committee, under the chairmanship of Dick Blount, met on March 15, 1951, and made strides in their ambitious program. At the previous meeting three subcommittees had been formed to study and report on: (1) power distribution and control, (2) lighting techniques, and (3) terminology and measurements. These problems were discussed and the chairmen of the three subcommittees (H. A. Kliegl, H. M. Gurin and R. L. Zahour) agreed to prepare written reports to form the basis of the Committee's report scheduled for presentation during the Spring Convention.

The scope of the Power Distribution and Control Subcommittee was expanded to include also a study of the mechanical supports required for both power and lamp equipment. To indicate this broader scope, the name of the group was changed to Lighting Facilities.

Definitions of three general categories of lighting (1, base; 2, accent; and 3, effects) were reached after appreciable discussion. The terminology Subcommittee was then asked to study the many subdivisions of accent lighting and prepare definitions of the terms, now in use or proposed, for future consideration of the Committee.

TV Leader

The Films for Television Leader Subcommittee, chaired by C. L. Townsend, met in late March, 1951, and continued their efforts to secure agreement on a standard threading leader for both the film and television industries. At previous meetings it has been agreed that the best test of the new leader would be its widespread use in either field. It was noted there are three television studios now using the proposed new leader (CBS, NBC, WOR) and ABC is about to start using it. In addition, several New York theater projectionists had studied the Leader and gave it their wholehearted approval.

In considering future action most useful for achieving industry-wide agreement on the Leader, it was agreed that widespread publicity on the new Leader was in order. This is to be accomplished by publication in the JOURNAL of an interim Committee report prepared by the Chairman.

New Members

The following members have been added to the Society's rolls since those published last month. The designations of grades are the same as those used in the 1950 MEMBERSHIP DIRECTORY.

Honorary (**H**) Fellow (**F**) Active (**M**) Associate (**A**) Student (**S**)

Barkofsky, Ernest C., Head Physicist, Microsecond Photography Section, U.S. Naval Ordnance Test Station. **Mail:** 71-B Rowe St., China Lake, Calif. (**A**)

Battey, Robert S., Development Engineer, EastmanKodak Co. **Mail:** 1560 Fairport-Webster Road, Penfield, N.Y. (**A**)

Bellamy, Ben C., Civil Engineer, Bellamy & Sons. **Mail:** Box 37, Laramie, Wyo. (**A**)

Bodkins, Arthur, Commercial, Ciné and Still Photographer. **Mail:** 69 Locust St., Winthrop, Mass. (**A**)

Brown, Warner M., Film Technician, Precision Film Laboratory. **Mail:** 111 Sullivan St., New York 12, N.Y. (**A**)

Cameron, James R., Jr., Projectionist, Tropicaire Drive-In Theater. **Mail:** 7400 S.W. 19 Street Road, Miami, Fla. (**A**)

Dunn, Donald E., Motion Picture Specialist—Editor, Sound Recording Engineer and Writer, North American Aviation, Inc. **Mail:** 5726 Budlong Ave., Los Angeles 37, Calif. (**A**)

Eddy, William C., President, Television Associates, Inc. **Mail:** E. Michigan St., Michigan City, Ind. (**M**)

Ervin, Russell T., Associate Producer, Grantland Rice Sportlight. **Mail:** 22 W. 48 St., New York, N.Y. (**M**)

Fischer, H. W., Technical Service Manager, Carl Zeiss, Inc. **Mail:** 3321 Bruckner Blvd., Apt. 3F, New York 61, N.Y. **(A)**

Flaherty, John P., Moving Picture Projectionist, Radio and Television Technician. **Mail:** 761 Harrison Ave., Louisville, Ky. **(M)**

Frenette, Charles, Television Technical Director, Canadian Broadcasting Corp. **Mail:** 5200 Hingston Ave. N.D.G., Montreal, Canada. **(A)**

Galante, James W., Director of Photography, American Television, Inc. **Mail:** 4738 W. Congress St., Chicago 44, Ill. **(A)**

Gibson, Gordon O., Theater Equipment Engineer, Atlas Theatre Supply Co. **Mail:** 425 Van Braam St., Pittsburgh, Pa. **(A)**

Grunkemeyer, George W., Photographer. **Mail:** P.O. Box 899, 444 West Alger, Sheridan, Wyo. **(A)**

Harrold, Donald O., Sound Technician, Telefilm, Inc. **Mail:** 1349 Cherokee Ave., Hollywood 28, Calif. **(A)**

Heynick, Benjamin, Mechanical Engineer, Federal Manufacturing & Engineering Corp. **Mail:** 286 Eastern Parkway, Brooklyn 25, N.Y. **(A)**

Hipple, Paul N., Motion Picture Projectionist, Jay Emanuel (Senate Theatre). **Mail:** Linden Ave., Marysville, Pa. **(A)**

Hornstein, Hal, Manager, Joe Hornstein, Inc. **Mail:** 712 N.E. First Ave., Miami, Fla. **(A)**

Hotin, Roland A., Photographic Technologist, Bureau of Ordnance, U.S. Navy. **Mail:** BOQ—"C" NOTS, China Lake, Calif. **(M)**

Hunt, Clyde M., Director of Engineering and Operations, WTOP, Inc., Warner Building, Washington 4, D.C. **(M)**

Johnson, F. Eugene, Sales Service, Eastman Kodak Co., 343 State St., Rochester, N.Y. **(M)**

Jones, Ernest D., Motion Picture Cameraman, Boeing Airplane Co. **Mail:** 4508 W. Mass, Seattle 6, Wash. **(A)**

Klein, Jerry, Video Recording Engineer, American Broadcasting Co. **Mail:** 513 Kings Highway, Brooklyn 23, N.Y. **(A)**

Kogel, Henry, Staff Engineer, SMPTE, **Mail:** 500 A Grand St., New York 2, N.Y. **(A)**

Komow, Victor H., Free-lance Cameraman, Film Director and Soundman. **Mail:** 248 E. 34 St., New York 16, N.Y. **(A)**

Love, Edgar J., General Engineering Manager, WWJ, The Detroit News. **Mail:** 9264 Boleyn, Detroit 24, Mich. **(M)**

Martin, Leslie, U.S. Navy. **Mail:** Box #48, U.S. Naval Station, Navy #230, c/o Postmaster, Seattle, Wash. **(A)**

McIntire, Harry R., Hollywood Sound Inst. **Mail:** 1023 N. Edgemont St., Los Angeles, Calif. **(S)**

Morrison, Arthur Q., Laboratory Manager, Society for Visual Education. **Mail:** 1934 Ridge Road, Homewood, Ill. **(A)**

Motyl, Ernest C., Production Supervisor, J. Walter Thompson Co., 420 Lexington Ave., New York 17, N.Y. **(A)**

Nass, Leonard I., Polytechnic Inst. of Brooklyn. **Mail:** 1065 Jerome Ave., Bronx 52, N.Y. **(S)**

Patterson, Victor E., Custom-built Laboratory Equipment and Camera Conversions. **Mail:** 5805 44 Ave., Hyattsville, Md. **(M)**

Radsliff, John L., Senior Electronics Technician, University of California Radiation Laboratory. **Mail:** 1134 Delaware, Apt. C., Berkeley, Calif. **(A)**

Raguse, Roy H., Sound Recording Engineer, Hal Roach Studios. **Mail:** 3518 S. Sycamore Ave., Los Angeles 16, Calif. **(A)**

Read, Morton H., Film Producer, Bay State Film Productions, Inc. **Mail:** 458 Bridge St., Springfield, Mass. **(M)**

Ricci, Eduardo J., New York University. **Mail:** 10 Park Terrace East, New York 34, N.Y. **(S)**

Rossini, Dino, President, Radiant Laboratories, Inc. **Mail:** 340 E. 66 St., New York 21, N.Y. **(M)**

Ruley, David, Television and Film Cameraman, Columbia Broadcasting System. **Mail:** 6 Field End Lane, Tuckahoe 7, N.Y. **(A)**

Shields, Daniel W., Film Director, WFMY-TV. **Mail:** 908 Park Avenue, Greensboro, N.C. **(A)**

Smith, Arthur Maxwell, Technical Supervisor, British Paramount News. **Mail:** 14 Lynton Ave., N. Finchley, London, England. **(M)**

Smith, Carl E., Vice-President in Charge of Engineering, United Broadcasting Co. **Mail:** 5000 Euclid Ave., Cleveland 3, Ohio. **(M)**

Strickland, John LeRoy, Projectionist, Herbert Rosner Co. **Mail:** 849 W. 94 St., Los Angeles 44, Calif. **(A)**

Uecke, Edward H., Electronics Engineer, Capitol Records, Inc. **Mail:** 4529 Mont Eagle Place, Los Angeles 41, Calif. **(A)**

Weller, Donald A., Radio Engineer, Chief Engineer, WISN. **Mail:** 819 E. Beaumont Ave., Milwaukee 11, Wis. **(M)**

Westfall, Ralph, Technical Assistant, Eastman Kodak Co. **Mail:** 3740 Willowcrest Ave., North Hollywood, Calif. **(A)**

CHANGES IN GRADE

Decker, H. M., Motion Picture Projectionist, Sunset Drive-In Theater. **Mail:** 1421 Garden St., San Luis Obispo, Calif. **(S)** to **(A)**

Walker, Algernon G., Newsreel Cameraman, KITV. **Mail:** 13436 Wingo St., Pacoima, Calif. **(S)** to **(A)**

New Products

Further information about these items can be obtained directly from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of news items does not constitute an endorsement.

This new portable television camera and transmitting station, designed to operate in the field as a one-man back-pack unit, was demonstrated by L. E. Flory, of the RCA Laboratories, at a meeting of the Institute of Radio Engineers in New York on March 22. In the illustration, J. E. Dilley, of the RCA Laboratories staff, is demonstrating, and standing to the right is Dr. V. K. Zworykin, Vice-President and Technical Consultant of the RCA Laboratories, who directed research and development work on the equipment.

Weighing only 53 lb, the back-pack station is planned to function with its own battery-power supply. Numerous applications for the new equipment are foreseen by RCA research engineers, including news coverage, with television-equipped reporters flashing pictures and commentary directly to editorial rooms, and remote industrial viewing and control.

The new transmitter operates in conjunction with a control station which may be located as far as a mile from the camera. Signals corresponding to the scene being televised are transmitted to the control point on an ultra-high frequency with a power of two watts. In addition to acting as a monitor for the televised picture, the control point performs two other functions. It sends out a stream of pulses which stabilize the camera and can be used also to issue vocal instructions to the cameraman.

Recent developments in the design of pencil-sized tubes and other sub-miniature components made possible the relatively small bulk and weight of the equipment. Two small antennas extend from the top of the pack and are used respectively to transmit the picture signal to a base station and to receive voice and control signals from that same point.

The camera is an adaptation of the RCA industrial TV camera using the Vidicon tube. As an added feature, the camera includes a miniature kinescope picture tube which serves as a view-finder for the cameraman.

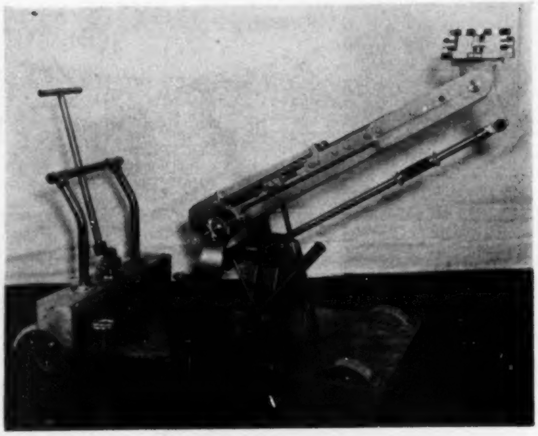
The equipment contains 42 tubes which, with their associated circuits, provide all synchronizing frequencies for a standard 525-line, 30-frame interlaced television picture. Included in the unit are the battery-operated power supply, deflecting circuits, amplifiers, and a radio receiver for operator instruction from the control point. A single battery operates the portable station for about 1½ hr.

The narrator-camerman's voice is picked up and transmitted through the combination of a small microphone built into the camera case and an ingenious electronic circuit which adds the voice signals to the picture signals as they are radiated to the control point.

Motion pictures team up with an electromechanical scoring device that metes out penalty points for automobile driver errors in the Automograph, an automatic driver-trainer developed by the Automograph Company, 30 Broad Street, New York, and used by the Aetna Casualty and Surety Co. which calls it the Aetna Roadometer in a national automobile safety campaign. The complete equipment projects a three-minute motor trip, records penalty points for each error in steering, braking, signaling, speed control and horn blowing, totals the driver's score and prints a report card with individual scores for each of nine separate driving problems. Also shown here is the "mechanical brain" with its lid off.

Scoring is accomplished by a series of counters and mechanical accumulators that compare the driver's actual performance over a period of 180 successive time units, with a theoretically "perfect" driver. A perfect match in every case gives a total score of zero, while the poorest score is 180. The signals to be matched are in the sound track area, film is a loop of 16-mm color, and operator instructions and examples of the consequences of improper driving are projected from a series of 2 × 2 color slides.

The Hydrolift Dolly is basically designed to permit fast changeover from high to low camera positions, or vice versa. The required time is reported as 5 sec for high to low and 20 sec for low to high. It is manufactured by National Cine Equipment, Inc., 20 W. 22d St., New York 10.

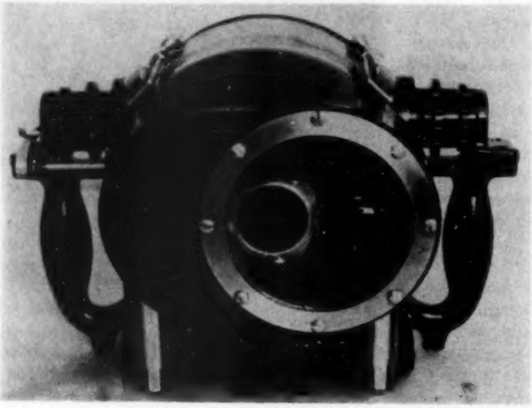


The dolly weighs about 395 lb and has these dimensions:

Over-all length
With arm in lowered position . 75 in.
With arm in raised position . . 55 in.
Over-all width . . . . 28 in.
Maximum height
To top of tripod head mounting base . . . . 69 in.
Minimum height
To top of tripod head mounting base . . . . 22 in.

The camera boom arm lift is operated by a hydraulic cylinder and powered by a manually operated pump. Downward movement is accomplished by gravity action on the oil cylinder. Rate of descent is controlled by a vernier screw arrangement, and the arm which can be stopped at any position is automatically locked by the hydraulic system.

The dolly is designed to accommodate any 16-mm or 35-mm professional camera or blimp, as well as TV cameras, the maximum load weight being 250 lb. The dolly can be equipped with an electrical hydraulic pump system to eliminate the manual operation.



An underwater motion picture camera and diving equipment, designed to permit a photographer to remain under water for an hour to an hour and a half, are now available from Fenjohn Underwater Photo & Equipment Co., Ardmore, Pa. That organization has been custom-making underwater photographic equipment for 22 years and is now producing the 16-mm camera in limited quantities. The assembly includes a Bell & Howell GSAP camera of 50-ft capacity, with an Elgeet

wide-angle 13-mm focal length $f/1.5$ lens, four filter mounts, an electric drive (self-contained batteries) which will operate approximately 1000 ft at sound speed and what Fenjohn reports are the only effective underwater color filters produced. Aperture, focus, filter and speed settings (of 12, 16, 24, 32, 48 or 64) may be made under water. Aperture, focus and filter settings and footage counter may be seen through the large viewfinder. The operator's thumb works the trigger. The housing is cast aluminum, and the equipment weighs 21 lb in the air and 3¾ lb under water. The camera is easily handled from a small boat, and it is reported that it can be hauled up, reloaded and returned to the swimmer in 30 sec.

Fenjohn says that good commercial-quality pictures may be made at 10 to 20 ft below the surface. The price is $1,790.

The Aqua-Lung, which was described in "U.S. Naval Underwater Cinematography Techniques," by R. R. Conger, (*Jour. SMPTE*, vol. 55, pp. 627–634, Dec. 1950), is a free swimming unit, light and easily transported, using compressed air. The Fenjohn Company, which distributes it, says that dives of over 400 ft have been accomplished with the lung and that it is standard equipment for the French Navy. They say that it "should be part of everyone's gear who is around the water for both enjoyment and practical purposes." It costs $139.50, delivered anywhere in the United States.

Meetings of Other Societies

American Physical Society, Apr. 26–28, Washington, D.C.

Acoustical Society of America, May 10–12, Washington, D.C.

American Physical Society, June 14–16, Schenectady, N.Y.

American Physical Society, June 25–28, Vancouver, Canada

American Institute of Electrical Engineers, June 25–29, Toronto, Canada

Illuminating Engineering Society, Aug. 27–30, Washington, D.C.

Biological Photographic Association, 21st Annual Meeting, Sept. 12–14, Kenmore Hotel, Boston, Mass.

National Electronics Conference, Seventh Annual Conference, Oct. 22–24, Edgewater Beach Hotel, Chicago. The conference is sponsored by the American Institute of Electrical Engineers, Institute of Radio Engineers, Illinois Institute of Technology, Northwestern University and the University of Illinois, with participation by the University of Wisconsin and the Society of Motion Picture and Television Engineers.

The American Institute of Physics is holding a twentieth anniversary meeting in Chicago on October 23–27. Its member societies will hold meetings at that time as follows:

- Acoustical Society of America, Oct. 23–25
- Optical Society of America, Oct. 23–25
- Society of Rheology, Oct. 24–26
- American Physical Society, Oct 25–27
- American Association of Physics Teachers, Oct. 25–27

Employment Service

POSITION AVAILABLE: Mechanical engineer, preferably experienced in design 35-mm projectors; salary open; state qualifications and salary requirements for permanent position; write to: H. T. Matthews, President, Motiograph, Inc., 4431 W. Lake St., Chicago 24, Ill.

Committees of the Society

As of March 15, 1951

Administrative Committees

ADMISSIONS. *To pass upon all applications for membership, applications for transfer, and to review the Student and Associate membership list periodically for possible transfer to the Associate and Active grades, respectively. The duties of each committee are limited to applications and transfers originating in the geographic area covered.*

E. A. Bertram, *Chairman, East*, DeLuxe Laboratories, 850 Tenth Ave., New York 19

C. R. Keith — W. B. Lodge — E. I. Sponable

Bertel J. Kleerup, *Chairman, Central*, Society for Visual Education, 1345 W. Diversey Parkway, Chicago 14, Ill.

E. E. Bickel — Lloyd Thompson — M. G. Townsley

N. L. Simmons, *Chairman, West*, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38, Calif.

T. T. Moulton — E. H. Reichard — Petro Vlahos

BOARD OF EDITORS. *To pass upon the suitability of all material submitted for publication, or for presentation at conventions, and publish the* JOURNAL.

Arthur C. Downes, *Chairman*, 2181 Niagara Dr., Lakewood 7, Ohio

G. M. Best	A. M. Gundelfinger	G. E. Matthews	R. T. Van Niman
L. B. Browder	C. W. Handley	Pierre Mertz	J. H. Waddell
C. R. Fordyce	A. C. Hardy	H. W. Pangborn	D. R. White
L. D. Grignon	C. R. Keith	N. L. Simmons	

EUROPEAN ADVISORY COMMITTEES. *To act as liaison between the general Society and European firms, individuals, and organizations interested in motion picture and television engineering. To report to the Society on such affairs in Europe, on new technical developments, and to assist the Papers Committee in soliciting papers for publication in the* JOURNAL.

I. D. Wratten, *Chairman* (*British Division*), Kodak, Ltd., Kingsway, London, England

R. H. Cricks — W. M. Harcourt — L. Knopp — A. W. Watkins

L. Didiée, *Chairman* (*Continental Division*) Association Francaise des Ingénieurs et Techniciens du Cinéma, 92 Champs-Elysées, Paris (8e), France

R. Alla	M. Certes	S. Feldman	M. Terrus
R. Bocquel	J. Cordonnier	J. Fourrage	J. Vivié
		G. Mareschal	M. Yvonnet

FELLOW AWARD. *To consider publications of Active members as candidates for elevation to Fellow, and to submit such nominations to the Board of Governors.*

Earl I. Sponable, *Chairman*, Movietonews, Inc., 460 W. 54 St., New York 19

Ralph B. Austrian	F. T. Bowditch	Robert M. Corbin	W. C. Kunzmann
Herbert Barnett	F. E. Cahill	Charles R. Daily	Peter Mole
	George W. Colburn	John G. Frayne	E. M. Stifle

HISTORICAL AND MUSEUM. *To collect facts and assemble data relating to the historical development of the motion picture and television industries, to encourage pioneers to place their work on record in the form of papers for publication in the* JOURNAL, *and to place in suitable depositories equipment pertaining to the industry.*

E. A. Bertram, *Chairman*, DeLuxe Laboratories, Inc., 850 Tenth Ave., New York 19

(Under Organization)

HONORARY MEMBERSHIP. *To search diligently for candidates who through their basic inventions or outstanding accomplishments have contributed to the advancement of the motion picture industry and are thus worthy of becoming Honorary members of the Society.*

Gordon Chambers, *Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

Carroll H. Dunning, Philo T. Farnsworth, Barton Kreuzer, Loren L. Ryder

JOURNAL AWARD. *To recommend to the Board of Governors the author or authors of the most oustanding paper originally published in the* JOURNAL *during the preceding calendar year to receive the Society's* JOURNAL *Award.*

F. J. Kolb, Jr., *Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

Paul Arnold, A. N. Goldsmith, Joseph H. Spray

NOMINATIONS. *To recommend nominations to the Board of Governors for annual election of officers and governors.*

Earl I. Sponable, *Chairman*, Movietonews, Inc., 460 W. 54 St., New York 19

Herbert Barnett	Nathan D. Golden	William B. Lodge	Charles H. Percy
G. L. Carrington	D. E. Hyndman	Peter Mole	Richard Warn

PAPERS. *To solicit papers and provide the program for semiannual conventions, and make available to local sections for their meetings papers presented at national conventions.*

Edward S. Seeley, *Chairman*, Altec Service, 161 Sixth Ave., New York 13

Joseph E. Aiken, *Vice-Chairman*, 116 No. Galveston St., Arlington, Va.

F. G. Albin, *Vice-Chairman*, American Broadcasting Co., Station KECA-TV, 4151 Prospect Ave., Hollywood, Calif.

G. G. Graham, *Vice-Chairman*, National Film Board of Canada, John St., Ottawa, Canada

W. H. Rivers, *Vice-Chairman*, Eastman Kodak Co., 342 Madison Ave., New York 17

R. T. Van Niman, *Vice-Chairman*, 4441 Indianola Ave., Indianapolis, Ind.

John H. Waddell, *Vice-Chairman*, Wollensak Optical Co., 850 Hudson Ave., Rochester, N.Y.

A. C. Blaney	Farciot Edouart	P. A. Jacobson	W. J. Morlock
Richard Blount	F. L. Eich	William Kelley	Herbert Pangborn
R. P. Burns	Dudley Goodale	E. P. Kennedy	Edward Schmidt
Philip Caldwell	Charles Handley	George Lewin	N. L. Simmons
F. O. Calvin	R. N. Harmon	E. C. Manderfeld	S. P. Solow
Howard Chinn	Scott Helt	Glenn Matthews	J. G. Stott
J. P. Corcoran	C. E. Heppberger	Pierre Mertz	W. L. Tesch
G. R. Crane	J. K. Hilliard	James Middlebrooks	S. R. Todd
E. W. D'Arcy	L. Hughes	Harry Milholland	M. G. Townsley

PROGRESS. *To prepare an annual report on progress in the motion picture and television industries.*

C. W. Handley, *Chairman*, 1960 West 84 St., Los Angeles 44, Calif.

J. E. Aiken	J. W. Duvall	G. R. Groves	W. A. Mueller
W. L. Bell	T. J. Gibbons	W. F. Kelley	B. F. Perry
P. G. Caldwell	G. H. Gordon	R. E. Lewis	E. H. Reichard
			W. L. Tesch

PROGRESS MEDAL AWARD. *To recommend to the Board of Governors a candidate who by his inventions, research, or development has contributed in a significant manner to the advancement of motion picture technology, and is deemed worthy of receiving the Progress Medal Award of the Society.*

David B. Joy, *Chairman*, National Carbon Division, 30 E. 42 St., New York 17

Max Batsel | F. H. McIntosh | George Mitchell | D. R. White

DAVID SARNOFF AWARD. *To recommend to the Board of Governors a candidate who has done outstanding work in some technical phase of the broad field of television or in any similar phase of theater television, whether in research, development, design, manufacture or operation.*

Pierre Mertz, *Chairman*, Bell Telephone Laboratories, Inc., 463 West St., New York 14

Raymond L. Garman | T. T. Goldsmith | William B. Lodge

SUSTAINING MEMBERSHIP. *To solicit new sustaining members and thereby obtain adequate financial support required by the Society to carry on its technical and engineering activities.*

Earl I. Sponable, *Chairman*, Movietonews, Inc., 460 W. 54 St., New York 19

D. B. Joy | S. P. Solow

SAMUEL L. WARNER AWARD. *To recommend to the Board of Governors a candidate who has done the most outstanding work in the field of sound motion picture engineering, in the development of new and improved methods or apparatus designed for sound motion pictures, including any steps in the process, and who, whether or not a Member of the Society of Motion Picture and Television Engineers, is deemed eligible to receive the Samuel L. Warner Memorial Award of the Society.*

Glenn L. Dimmick, *Chairman*, RCA Victor Division, Front and Cooper Sts., Camden, N.J.

Lloyd Goldsmith | John Hilliard | John Maurer | Otto Sandvik

Engineering Committees

COLOR. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of color motion picture processes, accessory equipment, studio lighting, selection of studio set colors, color cameras, color motion picture films, and general color photography. (File 10)*

H. H. Duerr, *Chairman*, Ansco, Binghamton, N.Y.

R. H. Bingham	R. O. Drew	L. T. Goldsmith	C. F. J. Overhage
M. R. Boyer	A. A. Duryea	A. M. Gundelfinger	W. E. Pohl
H. E. Bragg	R. M. Evans	W. W. Lozier	G. F. Rackett
O. O. Ceccarini	J. G. Frayne	A. J. Miller	L. E. Varden

FILM DIMENSIONS. *To make recommendations and prepare specifications on those film dimensions which affect performance and interchangeability, and to investigate new methods of cutting and perforating motion picture film in addition to the study of its physical properties. (File 15)*

E. K. Carver, *Chairman*, Eastman Kodak Co., Kodak Park Works, Rochester 4, N.Y.

E. A. Bertram	A. M. Gundelfinger	W. E. Pohl	William Wade
A. F. Edouart	W. G. Hill	N. L. Simmons	Fred Waller
	A. J. Miller	M. G. Townsley	D. R. White

FILM-PROJECTION PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture projection equipment, projection rooms, film-storage facilities, stage arrangement, screen dimensions and placement, and maintenance of loudspeakers to improve the quality of reproduced sound and the quality of the projected picture in the theater.* (*File 20*)

M. D. O'Brien, *Chairman*, Projection and Sound Dept., Loew's Theaters, 1540 Broadway, New York 19

C. S. Ashcraft
Frank Cahill
Merle Chamberlin
Joseph Clayton
L. W. Davee
C. L. Greene
R. H. Heacock
Henry Heidegger
C. F. Horstman
G. T. Lorance
Robert Lucas
D. F. Lyman
H. T. Matthews
Stanley Perry
Paul Ries
Harry Rubin
Ben Schlanger
J. W. Servies
S. R. Todd

FILMS FOR TELEVISION. *To make recommendations and prepare specifications on all phases of the production, processing and use of film made for transmission over a television system excluding video transcriptions.* (*File 80*)

R. L. Garman, *Chairman*, General Precision Laboratory, Inc., 63 Bedford Road, Pleasantville, N.Y.

R. O. Drew
Richard Hodgson
S. E. Howse
R. Johnston
H. R. Lipman
Pierre Mertz
H. C. Milholland
G. C. Misener
R. M. Morris
R. C. Rheineck
H. J. Schlafly
N. L. Simmons
John G. Stott
C. L. Townsend
L. F. Transue
T. G. Veal

HIGH-SPEED PHOTOGRAPHY. *To make recommendations and prepare specifications for the construction, installation, operation, and servicing of equipment for photographing and projecting pictures taken at high repetition rates or with extremely short exposure times.* (*File 25*)

J. H. Waddell, *Chairman*. Wollensak Optical Co., 78 Brunswick St., Rochester 7, N.Y.

H. E. Edgerton, *Vice-Chairman*, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.

E. A. Andres, Sr.
K. M. Baird
D. M. Beard
H. W. Crouch
C. H. Elmer
R. E. Farnham
W. R. Fraser
Eleanor Gerlach
C. C. Herring
H. M. Lester
N. C. Lipton
C. D. Miller
A. P. Neyhart
W. S. Nivison
Brian O'Brien
D. H. Peterson
Earl Quinn
M. L. Sandell
Kenneth Shaftan
C. W. Wyckoff
A. M. Zarem

LABORATORY PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture printers, processing machines, inspection projectors, splicing machines, film-cleaning and treating equipment, rewinding equipment, any type of film-handling accessories, methods, and processes which offer increased efficiency and improvements in the photographic quality of the final print.* (*File 30*)

J. G. Stott, *Chairman*, Du Art Film Laboratories, 245 West 55 St., New York, N.Y.

V. D. Armstrong
H. L. Baumbach
D. P. Boyle
O. E. Cantor
Gordon Chambers
I. M. Ewig
T. M. Ingman
P. A. Kaufman
C. F. LoBalbo
J. A. Maurer
O. W. Murray
W.H.Offenhauser, Jr.
W. E. Pohl
E. H. Reichard
V. C. Shaner
J. H. Spray
Lloyd Thompson
Paul Zeff

MOTION PICTURE STUDIO LIGHTING AND PROCESS PHOTOGRAPHY. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of all types of studio and outdoor auxiliary lighting equipment, tungsten light and carbon-arc sources, lighting-effect devices, diffusers, special light screens, etc., to increase the general engineering knowledge of the art; and to make recommendations and prepare specifications on motion picture optical printers, process projectors (background process), matte processes, special process lighting technique, special processing machines, miniature-set requirements, special-effects devices, and the like, that will lead to improvement in this phase of the production art.* (*File 35*)

M. A. Hankins, *Chairman*, Mole-Richardson Co., 937 N. Sycamore Ave., Hollywood 38, Calif.

Richard Blount
J. W. Boyle
Karl Freund
C. W. Handley
C. R. Long
W. W. Lozier
D. W. Prideaux
Petro Vlahos

OPTICS. *To make recommendations and prepare specifications on all subjects connected with lenses and their properties.* (*File 40*)

R. Kingslake, *Chairman*, Eastman Kodak Co., Hawk Eye Works, Rochester 4, N.Y.

F. G. Back
A. A. Cook
C. R. Daily
I. C. Gardner
J. W. Gillon
Grover Laube
J. L. Maulbetsch
J. A. Maurer
G. A. Mitchell
A. E. Murray
W. E. Pohl
L. T. Sachtleben
O. H. Schade
M. G. Townsley

PRESERVATION OF FILM. *To make recommendations and prepare specifications on methods of treating and storage of motion picture film for active, archival, and permanent record purposes, so far as can be prepared within both the economic and historical value of the films.* (*File 45*)

J. W. Cummings, *Chairman*, National Archives, Washington 25, D.C.

Henry Anderson
W. G. Brennan
J. W. Dunham
C. R. Fordyce
J. E. Gibson
G. Graham
A. C. Hutton
J. B. McCullough
N. F. Oakley
W. E. Pohl
W. D. Stump

PROCESS PHOTOGRAPHY. *This Committee has been combined with the Motion Picture Studio Lighting Committee and will no longer be listed as a separate organization.*

SCREEN BRIGHTNESS. *To make recommendations, prepare specifications, and test methods for determining and standardizing the brightness of the motion picture screen image at various parts of the screen, and for special means or devices in the projection room adapted to the control or improvement of screen brightness.* (*File 55*)

W. W. Lozier, *Chairman*, National Carbon Div., Fostoria, Ohio

Herbert Barnett
H. J. Benham
F. E. Carlson
M. H. Chamberlin
E. R. Geib
L. T. Goldsmith
L. D. Grignon
A. J. Hatch, Jr.
L. B. Isaac
W. F. Kelley
F. J. Kolb
W. F. Little
L. J. Patton
Leonard Satz
J. W. Servies
B. A. Silard
Allen Stimson
C. R. Underhill, Jr.
H. E. White
A. T. Williams
D. L. Williams

16-MM AND 8-MM MOTION PICTURES. *To make recommendations and prepare specifications for 16-mm and 8-mm cameras, 16-mm sound recorders and sound-recording practices, 16-mm and 8-mm printers and other film laboratory equipment and practices, 16-mm and 8-mm projectors, splicing machines, screen dimensions and placement, loudspeaker output and placement, preview or theater arrangements, test films, and the like, which will improve the quality of 16-mm and 8-mm motion pictures.* (*File 60*)

H. J. Hood, *Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

H. W. Bauman
W. C. Bowen
F. L. Brethauer
F. E. Brooker
F. E. Carlson
S. L. Chertok
E. W. D'Arcy
G. A. Del Valle
J. W. Evans
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John Forrest
R. C. Holslag
Rudolf Kingslake
W. W. Lozier
D. F. Lyman
W. C. Miller
J. R. Montgomery
J. W. Moore
W. H. Offenhauser, Jr.
A. G. Petrasek
A. C. Robertson
L. T. Sachtleben
H. H. Strong
Lloyd Thompson
M. G. Townsley

SOUND. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture film, sound recorders, re-recorders, and reproducing equipment, methods of recording sound, sound-film processing, and the like, to obtain means of standardizing procedures that will result in the production of better uniform quality sound in the theater.* (*File 65*)

L. T. Goldsmith, *Chairman*, Warner Brothers Pictures, Burbank, Calif.

G. L. Dimmick, *Vice-Chairman*, RCA Victor Division, Camden, N.J.

F. G. Albin	E. W. D'Arcy	J. K. Hilliard	Otto Sandvik
H. W. Bauman	R. J. Engler	L. B. Isaac	G. E. Sawyer
R. J. Beaudry	R. M. Fraser	E. W. Kellogg	R. R. Scoville
A. C. Blaney	J. G. Frayne	J. P. Livadary	W. L. Thayer
D. J. Bloomberg	L. D. Grignon	K. M. MacIlvain	M. G. Townsley
F. E. Cahill, Jr.	Robert Herr	W. C. Miller	R. T. Van Niman
		G. C. Misener	D. R. White

STANDARDS. *To survey constantly all engineering phases of motion picture production, distribution, and exhibition, to make recommendations and prepare specifications that may become proposals for American Standards. This Committee should follow carefully the work of all other committees on engineering and may request any committee to investigate and prepare a report on the phase of motion picture engineering to which it is assigned.* (*File 70*)

F. E. Carlson, *Chairman*, General Electric Company, Nela Park, Cleveland 12, Ohio

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Richard Blount	H. H. Duerr	M. A. Hankins	F. J. Pfeiff
E. K. Carver	E. C. Fritts	H. J. Hood	J. W. Servies
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		W. W. Lozier	J. H. Waddell

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TELEVISION FILM EQUIPMENT (JOINT RTMA-SMPTE COMMITTEE.) *To make recommendations and prepare specifications on all phases of film equipment as used in the television broadcast stations.* (*File 75*)

F. N. Gillette, *RTMA*, *Chairman*, General Precision Laboratory, 63 Bedford Road, Pleasantville, N.Y.

E. C. Fritts, *SMPTE*, *Vice-Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

F. G. Albin	Sydney Cramer	H. C. Milholland	R. C. Rheineck
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Pierre Boucheron	E. C. Manderfeld	R. M. Morris	M. G. Townsley
P. F. Brown	J. A. Maurer	N. F. Oakley	H. E. White

TELEVISION STUDIO LIGHTING. *To make recommendations and prepare specifications on all phases of lighting employed in television studios.* (*File 85*)

Richard Blount, *Chairman*, General Electric Co., Nela Park, Cleveland 12, Ohio

H. R. Bell	D. D. Cavelli	H. A. Kliegl	Adrian Terlouw
A. H. Brolly	H. M. Gurin	Robert Morris	Malcolm Waring
		R. S. O'Brien	R. L. Zahour

TEST FILM QUALITY. *To develop and keep up to date all test film specifications, and to supervise, inspect and approve methods of production and quality control of all test films sold by the Society. (File 95)*

F. J. Pfeiff, *Chairman*, Altec Service Corp., 161 Sixth Ave., New York 13

R. M. Corbin, Russell Drew, W. F. Kelley, J. A. Maurer, Joseph Spray, J. G. Stott, M. G. Townsley

THEATER TELEVISION. *To make recommendations and prepare specifications for the construction, installation, operation, maintenance, and servicing of equipment for projecting television pictures in the motion picture theater, as well as projection-room arrangements necessary for such equipment, and such picture-dimensional and screen-characteristic matters as may be involved in high-quality theater-television presentations. (File 90)*

G. L. Beers, *Chairman*, RCA Victor Div., Camden, N. J.

Ralph Austrian, F. E. Cahill, Jr., James Frank, Jr., R. L. Garman, E. P. Genock, A. N. Goldsmith, T. T. Goldsmith, Jr., E. D. Goodale, Nate Halpern, Richard Hodgson, C. F. Horstman, D. E. Hyndman, L. B. Isaac, A. G. Jensen, P. J. Larsen, Nathan Levinson, W. W. Lozier, G. P. Mann, R. H. McCullough, F. R. Norton, Harry Rubin, L. L. Ryder, Otto Sandvik, Ed Schmidt, A. G. Smith, E. I. Sponable, J. E. Volkmann

THEATER ENGINEERING. *To make recommendations and prepare specifications of engineering methods and equipment of motion picture theaters in relation to their contribution to the physical comfort and safety of patrons, so far as can be enhanced by correct theater design, construction, and operation of equipment. (File 100)*

J. W. Servies, *Chairman*, National Theatre Supply, 92 Gold St., New York 7.

F. W. Alexa, Henry Anderson, Charles Bachman, O. P. Beckwith, E. J. Content, C. M. Cutler, James Frank, Jr., Aaron Nadell, E. H. Perkins, Leonard Satz, Ben Schlanger, Seymour Seider, Emil Wandelmaier

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Standards Council, D. E. Hyndman

SECTIONAL COMMITTEES

Standardization of Letter Symbols and Abbreviations for Science and Engineering, Z10, S. L. Chertok

Motion Pictures, PH22

J. A. Maurer, *Chairman*, J. A. Maurer, Inc., 37-01 31 St., Long Island City 1, N.Y.

F. T. Bowditch, F. E. Carlson, D. F. Lyman (alternate), Pierre Mertz

Acoustical Measurements and Terminology, Z24, H. F. Olson

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R. M. Evans, *Chairman*, Eastman Kodak Co., 59 Kodak Park, Rochester 4, N.Y.

J. A. Ball, F. T. Bowditch, M. R. Boyer, H. E. Bragg, A. M. Gundelfinger, H. C. Harsh, W. H. Ryan

UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION

R. E. Farnham, *Chairman*, General Electric Co., Nela Park, Cleveland 12, Ohio

Herbert Barnett, H. E. White

Society of Motion Picture and Television Engineers

342 Madison Avenue, New York 17, N.Y., Tel. MUrray Hill 2-2185
Boyce Nemec, *Executive Secretary*

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